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ORONO

BULLETIN 306 JUNE, 1922

STUDIES IN MILK SECRETION.

XVII. Relation between Milk Yields and Butter-Fat Percentages of the 7-day and 365-day Tests of Holstein-Friesian Advanced Registry Cattle.

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BULLETIN 306

STUDIES IN MILK SECRETION.[1]

XVII. Relation between Milk Yields and Butter-Fat Percentages of the 7-day and 365-day Tests, of Holstein-Friesian Advanced Registry Cattle.

By Marie S. Gowen and John W. Gowen.

Introduction.

During the course of their development two of our leading dairy breeds, the Jersey and the Holstein-Friesian, have made extensive use of the 7-day test. The Jersey breed has now practically discontinued the use of the 7-day record advocating the 365-day record as the only measure of the cow's worth as a milk producer. The discussion of the merits of the short time test and the long time test has recently entered a highly controversial stage even among its chief adherents, the Holstein-Friesian breeders. Few, if any, of the supporters of either camp have actively asserted that the long time test was not desirable. The contest has centered on the validity of the 7-day test as a measure of the cow's subsequent performance.

This question is intricate. It is really one phase of the larger question of the normal fluctuating variability of milk yield. In fact, it is from this angle that the authors were led into this problem, for whatever significance may be attached to this variability, a fairly comprehensive knowledge of its magnitude forms a necessary prelude to the further use of such data for genetic studies.

The validity of the 7-day test has been attacked chiefly by assertion rather than by the presentation of analyzed data. As a basis of investigation some of these statements are presented for further analysis.

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[1]Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 149. This paper is one of a series of investigations in animal husbandry the continued prosecution of which has been made possible by a grant to the author from the Rockefeller Institute for Medical Research.

(1) The butter-fat percentage for the 7-day record is generally larger than the butter-fat percentage for the 365-day test. From this, it is argued that the 7-day record is invalid. It might equally well be argued that the 7-day test for milk yield is also invalid because its milk yield is not the same as the 365-day milk yield.

(2) The butter-fat percentage is claimed to be increased artificially through feeding, by causing the cow to lay on loose fat. This loose fat is secreted into the milk thus raising the 7-day butter-fat percentage above what it should be. The claim is also made that the 7-day test of five or six years ago is more indicative of the cow's milk producing capacity in the year test than is the 7-day test of today, because it is but recently that the trick of manipulating the butter-fat percentage by feeding has become generally known. The inference is made that the 365-day test is not equally affected by such manipulation. It is also inferred that this feeding in the 7-day test levels off the differences shown by the high and low testing cows in the records of longer duration.

(3) The argument is presented that the best quarter mile horses are seldom the best mile racers and that the best laying hens for the month are seldom the best for the year, therefore, why should the 7-day record indicate the worth of the cow for the long time test.

These three contentions present questions relating to important problems of the physiology of the dairy cow. The supporters of the 7-day test have chiefly argued for it as a matter of expediency, i. e. a preparatory school for the long test; development of the breed, that its discontinuence would be unfair to those men owning 7-day test cows or cows whose value depends largely on the 7-day tests in their pedigrees. These are not questions of physiology and, although they be none the less important to the Holstein-Friesian breeder, have no place in investigational work aimed primarily at the fundamental problems of the dairy cow.

The physiological questions indicated above lead to the more concise questions on which data will be subsequently presented.

a. Does the 365-day test predict the relative[2] milk yield, and butter-fat percentage of a subsequent 365-day lactation with sufficient accuracy to make the 365-day test of value?

b. Does the 7-day test predict the relative milk yield and butter-fat percentage of the 365-day lactation record of which it is a part with sufficient accuracy to make the 7-day test of value?

c. Does the 7-day test predict the relative milk yield and butter-fat percentage of the 365-day lactation of which it is not a part with sufficient accuracy to make the 7-day test of value?

The second and third questions do not, of course, require that the 7-day test have a milk yield or a butter-fat percentage equal to the 365-day test. They only require that the position occupied by the cow among the blue book cows in her 7-day test shall be closely similar to the position occupied by this same cow in her year test. On this ground the fact that the 7-day test butter-fat percentage is higher than the year test butter-fat percentage has little weight for like the 7-day milk yield some knowledge must be had of what the conversion factors should be, before either test can predict, even approximately, the subsequent year record. Similar reasoning holds for the 365-day record of one lactation in comparison with that of another lactation. This brings up the next question.

d. Is it possible to determine for milk yield and butter-fat percentage the proper correction to be applied to the 7-day test to give a reasonable value to be expected in the 365-day test?

The assertion that the dependability of the seven day test in predicting the long time test has changed during the last few years, makes the analysis of this question desirable.

Materials and Methods

The Holstein-Friesian Advanced Registry[3] data used in this investigation were collected in connection with other studies. It

[2]The word *relative* is inserted here because, as is well known, the milk yields of cows change with age. The cow will not be expected to have the same number of pounds of milk in one lactation as in another but will rather be expected to maintain a milk yield such that she retain her relative position among her sister cows in the subsequent milk yields that she had in the previous semi-official test.

[3]Holstein-Friesian Association of America. 1907-20. Advanced Registry Year Books. V. 18-30.

is believed to include all the 365-day test and retest cows in the blue books up to number 31. It does not include all the records of cows tested for seven days and subsequently tested for 365 days. The data collected should be a good random sample of these 7-day cows which were subsequently tested for the 365-day period.

The methods employed were those in customary use where large quantities of numerical data are analyzed.

The calculation of the data to determine the relative value of the 7-day and 365-day test as an indicator of the cow's possibilities as a milker have been done for the separate age groups. This is made necessary because of the well known fact that milk yield changes with age. Under such conditions the increase of milk yield with age for the 7-day and 365-day of the same lactation will in and of itself increase the correlation coefficient should these data be lumped, especially should such lumping include the early ages. By similar reasoning the correlation coefficients for the 7-day test with the 365-day test and the 365-day test with the 365-day test at different lactations will be lowered if all data, irrespective of the cows' ages are lumped together.

The problems will be analyzed in separate parts, one for each variable. The first will deal with milk yield and the second with butter-fat percentage.

PART I. RELATION BETWEEN THE 7-DAY AND THE 365-DAY MILK YIELD

The arrangement of the different tables will be in the order given in the introduction. The whole number of 365-day records for test and retest cows is divided into separate age groups to reduce, in so far as possible, the effect of age on milk yield. The means, standard deviations and coefficients of variation for the 365-day records with the 365-day records are given in Table 1.

The reader will remember that Holstein-Friesian[4] milk yield has been shown to increase at an ever declining rate until it reaches the maximum at 8 years and 5 months. From this point

[4]Gowen, John W. Studies in Milk Secretion VIII. On the influence of age on milk yield and butter-fat percentage as determined from the 365 day records of Holstein-Friesian cattle. In Annual Report of the Maine Agricultural Experiment Station for 1920. Bulletin 293. pp. 185-196.

TABLE 1.

Physical Constants for the Variation of 365-Day Milk Yield in Test and Retest Cows

Age Test — Retest	Mean First Test	Standard Deviation First Test	Coefficients of Variation First Test
1 yr. 9 mo. to 3 yrs. and 3 yrs. to 4 yrs.	14,033±266	2647±188	18.9±1.4
2 yrs. to 3 yrs. and 4 yrs. to 5 yrs.	12,935±301	3026±213	23.4±1.7
2 yrs. to 3 yrs. and 5 yrs. to 8 yrs.	13,221±294	2856±208	21.6±1.7
3 yrs. to 4 yrs. and 4 yrs. to 5 yrs.	15,167±600	3771±424	24.9±3.0
3 yrs. to 4 yrs. and 5 yrs. to 8 yrs.	16,723±422	3757±299	22.5±1.8
4 yrs. to 5 yrs. and 5 yrs. to 11 yrs.	16,523±375	3650±265	22.1±1.7
5 yrs. to 11 yrs. and 6 yrs. to 13 yrs.	19,157±382	4726±269	24.7±1.5

Age Test — Retest	Mean Retest	Standard Deviation Retest	Coefficients of Variation Retest
1 yr. 9 mo. to 3 yrs. and 3 yrs. to 4 yrs.	16,567±441	4389±312	26.5±2.0
2 yrs. to 3 yrs. and 4 yrs. to 5 yrs.	17,652±421	4237±298	24.0±1.8
2 yrs. to 3 yrs. and 5 yrs. to 8 yrs.	20,081±437	4244±309	21.1±1.6
3 yrs. to 4 yrs. and 4 yrs. to 5 yrs.	17.000±621	3905±439	23.0±2.7
3 yrs. to 4 yrs. and 5 yrs. to 8 yrs.	20,722±553	4922±391	23.8±2.0
4 yrs. to 5 yrs. and 5 yrs. to 11 yrs.	19,733±433	4209±306	21.3±1.6
5 yrs. to 11 yrs. and 6 yrs. to 13 yrs.	20,586±356	4417±252	21.5±1.2

the milk yield declines slightly as age advances. Since the age effect is greatest between the years 1 year and 9 months to five years, the attempt was made to make as many age divisions, during this time, as the data would allow. At the older age, where the age effect is less, the divisions are made broader.

The mean milk yields for the first tests at the different ages, as given in Table 1, are quite variable. Their average has a reasonable agreement with the milk yields for the whole breed as given in a previous paper.[5] This agreement would indicate that no selection of high milking cows for subsequent retest had been made.

If the mean milk yields of the retest cows are compared with the mean milk yield of the first test cows, the same ages being included in each group, it is found that the retest cows exceed the first test cows in milk yield. The excess milk yield for each age group is scarcely significant. Taken for all groups, where the data are weighted as the square root of n, the average differ-

[5]Loc. cit.

ence between the test and retest milk yields is 833 pounds. This difference is probably significant.

A similar difference between test and retest cows has been shown to exist in the Guernsey breed.[6] The effect of the first test is much more pronounced in the Guernsey than it is on these Holstein-Friesian cows.

Table 2 presents similar information for the milk yields of the Holstein-Friesian cows with 7-day and 365-day tests where the 7-day test is a part of the 365-day test.

If the average 7-day milk yields of Table 2 are compared with the average 7-day milk yields of all Holstein-Friesian[7] cows, recorded up to volume 25, of the advanced register, it is found that the 7-day test cows tested for 365-day records produce about 50 pounds of milk more than all the advanced registry cows. The mean milk yield of the 365-day tests for the different age groups is, on the whole, lower than the mean milk yield found for these age groups including all animals with 365-day tests recorded in the advanced registry up to volume 31. Individually considered these differences are not significant in comparison with their probable errors. The consistancy of the difference probably indicates that the 365-day records are slightly lower in milk yield. This is in line with what will be shown in a subsequent paper,—that there is a slightly significant increase of milk yield from dam to daughter in this breed. The cause of this increase is not known for it is a question whether it is due to better feeding and handling or to an actual accumulation of better hereditary factors for milk yield in the daughters of today in comparison with the dams of yesterday ascribable to a better perception of the laws of heredity underlying breeding operations.

The coefficients of variation give the comparative values of the variations of the 7-day and 365-day tests. The 7-day tests are proportionately less variable than the 365-day tests. The conclusion to be drawn from this fact is not sharply defined. It may be argued that since the 7-day test is less variable than the 365-day test it is a better measure of the cow's worth, or again

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[6]Gowen, John W. Studies in Milk Secretion X. The relation between the milk yield of one lactation and the milk yield of a subsequent lactation in Guernsey Advanced Registry Cattle. In press.

[7]Miner, John R. 1915. Fitting Logarithmic Curves by the Method of Moments. In Jour. Agri. Research, Vol. III, No. 5, pp. 411-423. Data in Table 1.

TABLE 2.

Physical Constants for the Variation of 7-Day and 365-Day Milk Yield Where the 7-Day Test is a Part of the 365-Day Test

Age	Mean 7-day Milk Yield	Standard Deviation 7-day Milk Yield	Coefficients of Variation 7-day Milk Yield
1 year 6 months and 2 years 0 months	304±4	48±3	15.8±1.1
2 years 0 months and 2 years 6 months	353±2	67±2	19.1±.5
2 years 6 months and 3 years 0 months	371±3	68±2	18.3±.6
3 years 0 months and 3 years 6 months	381±5	82±4	21.6±1.0
3 years 6 months and 4 years 0 months	430±5	76±3	17.8±.8
4 years 0 months and 4 years 6 months	465±6	79±4	17.0±.9
4 years 6 months and 5 years 0 months	467±6	83±5	17.8±1.0
5 years 0 months and 5 years 6 months	494±7	84±5	16.9±1.0
5 years 6 months and 6 years 0 months	508±7	87±5	17.2±.9
6 years 0 months and 6 years 6 months	495±7	71±5	14.3±1.0
6 years 6 months and 7 years 0 months	513±9	91±6	17.8±1.3
7 years 0 months and 7 years 6 months	503±9	80±6	16.0±1.2
7 years 6 months and 8 years 0 months	516±13	92±9	17.8±1.8
8 years 0 months and 8 years 6 months	542±15	91±10	16.9±2.0
8 years 6 months and 9 years 0 months	510±13	80±9	15.7±1.9
9 years 0 months and 9 years 6 months	485±10	55±7	11.4±1.4
9 years 6 months and 11 years 0 months	516±14	83±10	16.0±1.9
11 years 0 months and 15 years 0 months	508±19	69±13	13.5±2.8

Age	Mean 365-day Milk Yield	Standard Deviation 365-day Milk Yield	Coefficients of Variation 365-day Milk Yield
1 year 6 months and 2 years 0 months	11811±239	2585±169	21.9±1.5
2 years 0 months and 2 years 6 months	13548±100	2776±70	20.5±.5
2 years 6 months and 3 years 0 months	14160±134	2817±95	19.9±.7
3 years 0 months and 3 years 6 months	14667±173	2702±122	18.4±.8
3 years 6 months and 4 years 0 months	15333±189	3109±134	20.3±.9
4 years 0 months and 4 years 6 months	15901±289	3861±205	24.3±1.3
4 years 6 months and 5 years 0 months	17402±252	3272±178	18.8±1.1
5 years 0 months and 5 years 6 months	17694±318	3995±225	22.6±1.4
5 years 6 months and 6 years 0 months	17625±291	3861±206	21.9±1.2
6 years 0 months and 6 years 6 months	18157±299	3165±211	17.4±1.2
6 years 6 months and 7 years 0 months	18653±378	3926±267	21.0±1.5
7 years 0 months and 7 years 6 months	18450±368	3449±260	18.7±1.5
7 years 6 months and 8 years 0 months	19043±631	4486±446	23.6±2.5
8 years 0 months and 8 years 6 months	18111±480	3016±339	16.7±2.0
8 years 6 months and 9 years 0 months	17647±492	3009±348	17.0±2.0
9 years 0 months and 9 years 6 months	18400±290	1665±205	9.1±1.1
9 years 6 months and 11 years 0 months	16471±640	3913±453	23.8±2.9
11 years 0 months and 15 years 0 months	17667±1571	5706±1111	32.3±6.8

the argument may be that the 365-day test is more variable than the 7-day test because it tests out the producing capacities of all cows more thoroughly. The choice of either horn of this dilemma does not help much toward the true statement of the facts desired; i. e. the real worth of the two tests.

Table 3 gives the mean milk yields, the standard deviations and the coefficients of variation of the 7-day and 365-day test for those 7-day test cows which had another lactation record of 365 days at a different age.

TABLE 3.

Physical Constants for the Variation of the 7-Day and 365-Day Milk Yield Where the 7-Day Record is Made in a Separate Lactation from the 365-Day Milk Yield

Age 7-day Test and 365-day Test	Mean 7-day Milk Yield	Standard Deviation 7-day Milk Yield	Coefficients of Variation 7-day Milk Yield
2 yrs. to 3 yrs. and 3 yrs. to 4 yrs.	341±5	61±4	17.9±1.1
2 yrs. to 3 yrs. and 4 yrs. to 5 yrs.	325±6	55±4	16.9±1.4
2 yrs. to 3 yrs. and 5 yrs. to 6 yrs.	329±8	64±6	19.4±1.8
2 yrs. to 3 yrs. and 6 yrs. to 10 yrs.	305±6	50±4	16.4±1.3
3 yrs. to 4 yrs. and 4 yrs. to 5 yrs.	401±8	75±6	18.7±1.5
3 yrs. to 4 yrs. and 5 yrs. to 6 yrs.	437±12	90±9	20.5±2.1
3 yrs. to 4 yrs. and 6 yrs. to 10 yrs.	364±11	72±8	19.7±2.3
4 yrs. to 5 yrs. and 5 yrs. to 6 yrs.	430±7	57±5	13.3±1.2
4 yrs. to 5 yrs. and 6 yrs. to 10 yrs.	452±15	115±11	25.5±2.6
5 yrs. to 6 yrs. and 6 yrs. to 10 yrs.	465±10	85±7	18.3±1.6

Age 7-day Test and 365-day Test	Mean 365-day Milk Yield	Standard Deviation 365-day Milk Yield	Coefficients of Variation 365-day Milk Yield
2 yrs. to 3 yrs. and 3 yrs. to 4 yrs.	15869±335	3881±237	24.5±1.5
2 yrs. to 3 yrs. and 4 yrs. to 5 yrs.	15895±321	2936±227	18.5±1.4
2 yrs. to 3 yrs. and 5 yrs. to 6 yrs.	17630±464	3571±328	20.3±1.9
2 yrs. to 3 yrs. and 6 yrs. to 10 yrs.	17784±437	3940±309	22.2±1.8
3 yrs. to 4 yrs. and 4 yrs. to 5 yrs.	16103±359	3327±254	20.7±1.7
3 yrs. to 4 yrs. and 5 yrs. to 6 yrs.	18480±621	4605±439	24.9±2.5
3 yrs. to 4 yrs. and 6 yrs. to 10 yrs.	18211±539	3488±382	19.2±2.2
4 yrs. to 5 yrs. and 5 yrs. to 6 yrs.	17071±439	3443±310	20.2±1.9
4 yrs. to 5 yrs. and 6 yrs. to 10 yrs.	18077±461	3485±326	19.3±1.8
5 yrs. to 6 yrs. and 6 yrs. to 10 yrs.	18200±510	4142±361	22.8±2.1

The facts shown in Table 3 are essentially the same as those shown in the preceding tables. Our problem deals largely with the relative values of the 7-day test and the 365-day test as a measure of a cow's worth. The correlation coefficients to determine these relationships are given in the Table 4.

RELATIVE MERITS OF THE 7-DAY AND 365-DAY TESTS FOR MILK YIELD AS INDICATING THE COW'S PRODUCING CAPACITY.

TABLE 4.

Correlation Coefficients for the Variables 365-Day Milk Yield and 365-Day Milk Yield for Different Lactations, 7-Day Milk Yield and 365-Day Milk Yield for the Same Lactation, 7-Day Milk Yield and 365-Day Milk Yield for Different Lactations

365-day Milk Yield and 365-day Milk Yield Different Lactations. Age: Test / Retest	Correlation Coefficient
1 yr. 9 mo. to 3 yrs. and 3 yrs. to 4 yrs.	.733±.047
2 yrs. to 3 yrs. and 4 yrs. to 5 yrs.	.705±.050
2 yrs. to 3 yrs. and 5 yrs. to 8 yrs.	.480±.079
3 yrs. to 4 yrs. and 4 yrs. to 5 yrs.	.777±.062
3 yrs. to 4 yrs. and 5 yrs. to 8 yrs.	.702±.057
4 yrs. to 5 yrs. and 5 yrs. to 11 yrs.	.584±.068
5 yrs. to 11 yrs. and 6 yrs. to 13 yrs.	.689±.042
Mean	.667
Weighted Mean	.660

7-day Milk Yield and 365-day Milk Yield Same Lactation. Age	Correlation Coefficient
1 yr. 6 mo. and 2 yrs. 0 mo.	.653±.053
2 yrs. 0 mo. and 2 yrs. 6 mo.	.679±.019
2 yrs. 6 mo. and 3 yrs. 0 mo.	.624±.029
3 yrs. 0 mo. and 3 yrs. 6 mo.	.355±.056
3 yrs. 6 mo. and 4 yrs. 0 mo.	.623±.037
4 yrs. 0 mo. and 4 yrs. 6 mo.	.732±.035
4 yrs. 6 mo. and 5 yrs. 0 mo.	.447±.062
5 yrs. 0 mo. and 5 yrs. 6 mo.	.584±.052
5 yrs. 6 mo. and 6 yrs. 0 mo.	.574±.050
6 yrs. 0 mo. and 6 yrs. 6 mo.	.634±.056
6 yrs. 6 mo. and 7 yrs. 0 mo.	.587±.063
7 yrs. 0 mo. and 7 yrs. 6 mo.	.477±.082
7 yrs. 6 mo. and 8 yrs. 0 mo.	.794±.052
8 yrs. 0 mo. and 8 yrs. 6 mo.	.518±.116
8 yrs. 6 mo. and 9 yrs. 0 mo.	.521±.119
9 yrs. 0 mo. and 9 yrs. 6 mo.	—.115±.172
9 yrs. 6 mo. and 11 yrs. 0 mo.	.740±.074
11 yrs. 0 mo. and 15 yrs. 0 mo.	.835±.083
Mean	.583
Weighted Mean	.598

7-day Milk Yield and 365-day Milk Yield Different Lactations. Age	Correlation Coefficient
2 yrs. to 3 yrs. and 3 yrs. to 4 yrs.	.451±.069
2 yrs. to 3 yrs. and 4 yrs. to 5 yrs.	.521±.080
2 yrs. to 3 yrs. and 5 yrs. to 6 yrs.	.592±.084
2 yrs. to 3 yrs. and 6 yrs. to 10 yrs.	.321±.099
3 yrs. to 4 yrs. and 4 yrs. to 5 yrs.	.318±.097
3 yrs. to 4 yrs. and 5 yrs. to 6 yrs.	.441±.109
3 yrs. to 4 yrs. and 6 yrs. to 10 yrs.	.555±.107
4 yrs. to 5 yrs. and 5 yrs. to 6 yrs.	.478±.098
4 yrs. to 5 yrs. and 6 yrs to 10 yrs.	.636±.079
5 yrs. to 6 yrs. and 6 yrs. to 10 yrs.	.441±.099
Mean	.475
Weighted Mean	.462

The correlation coefficients for the milk yield of the 365-day test with the milk yield of a subsequent 365-day lactation are all rather high for data dealing with milk yield. The average correlation coefficient for this relation is 0.667. The relation between the 7-day milk yield and the 365-day milk yield where the 7-day milk yield is in the lactation of the 365-day milk yield is less than the relation between the milk yields of two 365-day lactations. The relation between the milk yield of the 7-day test and the milk yield of the 365-day test where the 7-day test is in a separate lactation from the 365-day test is less than either of the two preceding correlations. From these considerations it follows that the 365-day test is a better indicator of a subsequent 365-day lactation's milk yield than is the 7-day test. The 7-day milk yield is a better indicator of the milk yield of a 365-day lactation of which it is a part than the 7-day milk yield is an indicator of the 365-day milk yield of another lactation. All of the correlation coefficients are high in comparison with those found heretofore for most economic quantitative characters. Such being the case it is well to consider any test for milk yield, however short it may be, in selecting dairy cows.

LINEARITY OF REGRESSION

The nature of the regression lines for the tables presented above is important. The correlation ratios and the tests for the linearity of the regression, correlation ratio squared minus the correlation coefficient squared, are given in Table 5.

TABLE 5.

Data for the Test of the Linearity of Regression for the Tables Whose Correlation Coefficients are presented in Table 4

365-day Milk Yield and 365-day Milk Yield Different Lactations. Age	Correlation Ratios	η^2-r^2
1 yr. 9 mo. to 3 yrs. and 3 yrs. to 4 yrs.	.837	.162±.074
2 yrs. to 3 yrs. and 4 yrs. to 5 yrs.	.780	.112±.063
2 yrs. to 3 yrs. and 5 yrs. to 8 yrs.	.784	.385±.100
3 yrs. to 4 yrs. and 4 yrs. to 5 yrs.	.919	.240±.136
3 yrs. to 4 yrs. and 5 yrs. to 8 yrs.	.890	.299±.103
4 yrs. to 5 yrs. and 5 yrs. to 11 yrs.	.769	.250±.089
5 yrs. to 11 yrs. and 6 yrs. to 13 yrs.	.790	.148±.057
Average	.824	

7-day Milk Yield and 365-day Milk Yield Same Lactation. Age	Correlation Ratios	η^2-r^2
1 yr. 6 mo. and 2 yrs. 0 mo.	.799	.213±.076
2 yrs. 0 mo. and 2 yrs. 6 mo.	.684	.007±.006
2 yrs. 6 mo. and 3 yrs. 0 mo.	.668	.057±.022
3 yrs. 0 mo. and 3 yrs. 6 mo.	.529	.538±.046
3 yrs. 6 mo. and 4 yrs. 0 mo.	.663	.051±.027
4 yrs. 0 mo. and 4 yrs. 6 mo.	.759	.040±.029
4 yrs. 6 mo. and 5 yrs. 0 mo.	.524	.075±.040
5 yrs. 0 mo. and 5 yrs. 6 mo.	.664	.101±.048
5 yrs. 6 mo. and 6 yrs. 0 mo.	.658	.103±.046
6 yrs. 0 mo. and 6 yrs. 6 mo.	.676	.054±.043
6 yrs. 6 mo. and 7 yrs. 0 mo.	.704	.151±.069
7 yrs. 0 mo. and 7 yrs. 6 mo.	.541	.065±.053
7 yrs. 6 mo. and 8 yrs. 0 mo.	.812	.030±.048
8 yrs. 0 mo. and 8 yrs. 6 mo.	.735	.273±.142
8 yrs. 6 mo. and 9 yrs. 0 mo.	.570	.054±.074
9 yrs. 0 mo. and 9 yrs. 6 mo.	.819	.657±.165
9 yrs. 6 mo. and 11 yrs. 0 mo.	.847	.169±.122
11 yrs. 0 mo. and 15 yrs. 0 mo.	.972	.246±.237
Average	.701	

7-day Milk Yield and 365-day Milk Yield Different Lactations. Age	Correlation Ratios	η^2-r^2
2 yrs. to 3 yrs. and 3 yrs. to 4 yrs.	.596	.152±.062
2 yrs. to 3 yrs. and 4 yrs. to 5 yrs.	.561	.043±.044
2 yrs. to 3 yrs. and 5 yrs. to 6 yrs.	.669	.097±.077
2 yrs. to 3 yrs. and 6 yrs. to 10 yrs.	.388	.047±.047
3 yrs. to 4 yrs. and 4 yrs. to 5 yrs.	.455	.106±.067
3 yrs. to 4 yrs. and 5 yrs. to 6 yrs.	.527	.084±.075
3 yrs. to 4 yrs. and 6 yrs. to 10 yrs.	.785	.307±.143
4 yrs. to 5 yrs. and 5 yrs. to 6 yrs.	.738	.315±.118
4 yrs. to 5 yrs. and 6 yrs. to 10 yrs.	.666	.039±.052
5 yrs. to 6 yrs. and 6 yrs. to 10 yrs.	.587	.150±.088
Average	.597	

The correlation ratios, shown in Table 5, are all high in value. The year test milk yield has the highest average value in predicting the subsequent 365-day test milk yield. Of the 7-day tests, the test within the 365-day lactation predicts the year milk yield better than the 7-day test of another lactation.

The relation between the correlation ratios and the correlation coefficient shows that the regressions are probably all linear.

Relations Shown Between Economic Characters

It is desirable to have some comparative data to assist in the proper evaluation of the 7-day and 365-day test of Holstein-Friesian cattle as given above. Table 6 gives these for certain of our economic characters.

If a comparison is made between the 365-day tests of Guernsey and Holstein-Friesian cows, the reliability of these tests in predicting a subsequent 365-day retest is found to be practically the same. The average correlation for the Guernseys is .696 and for the Holstein-Friesian is .667. It takes but a glance at the rest of the table to show that these correlation coefficients are high. These tests are quite reliable in predicting the subsequent yield.

The advanced registry records appear to be more dependable than records taken for a whole herd as the correlation coefficients for the Jersey herd records are lower by about .1 than the advanced registry records. This may be due to the better preparation given to cows put on advanced registry test.

TABLE 6.

Correlation Coefficients Between Characters of Economic Importance

Character	Breed	Correlation	Authority
Milk yield and milk yield	Guernsey Advanced Registry	.462 to .811	Gowen[1]
Milk yield and milk yield	Jersey pure-bred herd	.214 to .731	Gowen[2]
Milk yield and milk yield (revised maximum)	British Holsteins and Shorthorns	.394 to .762	Gavin[3]
365-day yield and 365-day milk yield	Holstein-Friesian	.480 to .777	This paper
7-day milk yield and 365-day milk yield (same lactation)	Holstein-Friesian	—.115 to .835	This paper
7-day milk yield and 365-day milk yield (different lactation)	Holstein-Friesian	.318 to .636	This paper
Wool clip of one season and wool clip of another season	Ranbouillet	.51	Hill[4]
Lobe color and yearly egg production	White Leghorn	—.527 to —.582	Harris, Blakeslee and Warner[5]
Monthly egg yield and other 11 months' production	White Leghorn	.240 to .573	Harris and Blakeslee[6]
Milk yield and Score (Conformation)	Jersey Registry of Merit	—.070 to +.194	Gowen[7]

[1]Gowen, John W. 1921. The Relation between the Milk Yield of one lactation with the milk yield of a subsequent Lactation in Guernsey Advanced Registry Cattle. In press.

[2]Gowen, John W. 1920. Studies in Milk Secretion V. On the Variations and Correlations of Milk Secretion with Age. Genetics, Vol. 5, p. 111-188.

[3]Gavin, William. 1913. Studies in milk records on the accuracy of estimating a cow's milking capacity by her first lactation yield. Jour. Agric. Soc. Vol. 5, pp. 377-391.

[4]Hill, J. A. 1921. Studies in the Variation and Correlation of Fleeces from Range Sheep. Bulletin No. 127. Wyoming Agricultural Experiment Station, pp. 39-52.

[5]Harris, J. Arthur, Blakeslee, A. F., and Warner, D. E. 1917. The correlation between body pigmentation and egg production in the domestic fowl. Genetics 2, p. 36-81.

[6]Harris, J. Arthur, and Blakeslee, A. F. 1918. The correlation between egg production during various periods of the year in the domestic fowl. Genetics 3, p. 27-73.

[7]Gowen, John W. 1920. Conformation and its Relation to Milk Producing Capacity in Jersey Cattle. Jour. Dairy Scienee, Vol. III, No. 1, p. 1-32.

The next highest coefficients are those found for the 7-day test in relation to the year tests. These coefficients are also high. The reliability of the 7-day test is not quite as great as that for the year test. The 7-day test has a much greater value for predicting the year test than has any point of conformtion, in fact the 7-day test is nearly 2½ times as good an indicator of year milk yield as any of the conformation points are of year milk yield.

The comparison between the wool clip of one season as an indicator of the wool clip of subsequent seasons and a milk yield (7 or 365 days) as an indicator of a subsequent milk yield shows that the milk yield predicts the milk yield of a subsequent lacta-

tion slightly better than the amount of wool in the fleece of one season predicts the amount of wool in the fleece for other seasons.

It is of interest to note that the lobe color in White Leghorn pullets has about the same value in predicting what egg production may be expected from a bird,—as a milk record has in predicting the milk record of a subsequent lactation.

As noted in the introduction of this paper, the assertion was made that the best laying hens for a month are seldom the best laying hens for the year. It is interesting to view the evidence as presented in Table 6 for the white leghorn hens. While the correlations are not very large they show clearly that the egg production of a month does indicate what the egg production of the year will be. In fact the better the layer for the month the more chance it has to be good for the year. In fact were this not so, there would be little basis for culling chickens for the points used in culling are essentially those which indicate that the hens are laying at the time of culling. As Table 6 shows, the value of a milk record, either of 7-days or of 365-days duration, is greater as an indicator of the milk yield of a subsequent lactation record than the value of a monthly egg record is as an indicator of the year's production. Such being the case it does not seem justifiable to discard the 7-day test for the 365-day test when support is given to the monthly egg record as an indicator of the yearly production.

The authors know of no adequate analysis of any statistics on the relation of speed in trotting, running or pacing horses over the quarter mile and mile courses. In view of this lack of knowledge it would not be desirable to make the assertion that fast mile horses would probably be well up in the fast class of the quarter mile horses although from general experience with data of this kind it would seem as if such an assertion could be justified by subsequent analysis of data on trotting records.

EFFECT OF GROUPING ALL MILK RECORDS TOGETHER IN DETERMINING THE RELATION OF THE 7-DAY AND 365-DAY LACTATION RECORDS

The investigation of the effect of grouping all records together in determining the relation of the 7-day and 365-day lactation records is of interest as it throws some light on another's

research on this problem. In his study, Mr. Yapp[5] showed that the correlation coefficient for the semi-official and 7-day milk yields all lumped together is approximately +0.7. From this the conclusion is drawn that, "the correlation .702 is for certain purposes a high degree of correlation, but it is not a high degree of correlation between two measurements of the same thing." Continuing he says "it further follows that since the correlation between seven day and semi-official test is not high, it is not safe to attempt to use the seven day as a criterion by which to judge semi-official production." The point of this quotation all hinges on what correlation may be considered high for milk yield, etc., in dairy cattle and on the definition of "measurements of the same thing." By "measurements of the same thing" Mr. Yapp appears to mean the 365-day test. It seems to the authors, however, that what both measurements are aiming at is the total milk yield, etc., of the cow through her life time. If the authors' view is held, inquiry must be made into how accurately the 365-day test measures the cow's capacities as a producer of milk. In fact on either view such a comparison seems desirable.

If the data as analyzed in separate age groups for the correltion coefficients given in Table 4 are lumped together the correlation coefficients are obtained as shown in Table 7.

TABLE 7.

Correlation Coefficients Between 7-Day and 365-Day Milk Yields, the Age of Cow Disregarded

Characters Correlated	Correlation Coefficient
365-day milk yield and 365-day milk yield	.635±.023
7-day milk yield and 365-day milk yield (same lactation)	.749±.008
7-day milk yield and 365-day milk yield (different lactation)	.352±.027

The comparison is more favorable to the 7-day test within the lactation as a means of predicting that lactation's yield than it is to the 365-day test. It will be noted that this makes the conclusion of Mr. Yapp questionable. However, if the data are calculated for the separate age groups, as shown in Table 4, it

[5]Yapp, W. W. 1919. A study of the relative reliability of official tests of dairy cattle. In Bul. 215. Illinois Agr. Expt. Sta. pp. 323-329.

is seen that the truth of the matter is that the 365-day test is slightly better than the 7-day test as an indicator of milk yield. The difference in the results of these two tables is that the 7-day test correlation was increased artificially and the 365-day test correlation was decreased by lumping all records. It follows from this that the conclusions based on Table 4 are more likely to be correct than are conclusions based on the method, used by Mr. Yapp, of lumping records irrespective of age.

The lumping of all data for the 7-day test and the 365-day test for different lactations has reduced the true correlation considerably due to the influence of age on milk yield. The true worth of the 7-day test as an indicator of a year milk yield in another lactation is considerably greater than the figure shown in Table 7 as may be seen from an examination of Table 4.

CHANGES IN THE VALUE OF THE 7-DAY TEST AS AN INDICATOR OF THE YEAR TEST DURING THE PAST YEARS

As noted in the introduction, the claim has been made that in recent years the dairymen have been able, by proper feeding, to influence the 7-day test record so that it gives a false picture of the cow's true worth as a producer. This method of manipulating the feed is said to have come to light only in the past few years. From this it is asserted that the 7-day test today is less reliable than the 7-day test of some years ago in predicting the year test record. This assertion may be subjected to analysis to determine what grounds exist for it. The crucial evidence for or against this hypothesis comes in a comparison of the correlation coefficients for the 7-day and 365-day records for a group of cows tested early in the history of advanced registry testing and another group tested just recently. The data used for this point were the 2-year old and the 6- to 9-year old records of cows tested for 7- and 365-days in the same lactation. Such a division gives a group of young cows and a group of mature cows for comparison. The data on each group were split into approximately two equal parts. The first group for the 2-year olds contained herd book numbers from 66417 to 159419 and the second group's numbers were from 159486 to 211236. The groups for the 6- to 9-year old cows were 49440 to 95253 and 95273 to

158760. The correlations and their comparisons are given in Table 8.

TABLE 8.

Correlation Coefficients for 7-Day and 365-Day Milk Yields, Grouped to Determine the Relation Between Tests Made Recently and Tests Made Early in the Breed's History in Predicting 365-Day Milk Yield

Characters Correlated	Correlation Coefficient	Difference
Cows 2 years old		
Herd book nos. 66417 to 159419	.637±.023	
Herd book nos. 159486 to 211236	.506±.030	.131±.038
Cows 6 to 9 years old		
Herd book nos. 49440 to 95253	.572±.039	
Herd book nos. 95273 to 158760	.562±.040	.010±.053

The 2-year old cows show that the 7-day test was a slightly more reliable indicator of 365-day milk yield during the time it was first applied than it is today. The difference is small, amounting to only 3.4 times its probable error. The reliability of the 7-day test for the two groups of aged cows is the same, the difference being only an insignificant part of the probable error. If these differences are averaged it is clear that there has been no significant change in the value of the 7-day test in predicting the 365-day test within the duration of time covered by the data included in this paper. In view of this fact the assertion that the value of the 7-day test as an indicator of the 365-day test had become less in recent years, is untrue so far as these data are concerned.

Prediction Equations to Determine the Probable 365-Day Lactation Yield from the 7-Day or 365-Day Records

One of the chief criticisms of the 7-day test appears to come from the fact that the prediction equations to determine the probable 365-day test from the 7-day test are not known. Thus, the dairyman in viewing a record of 500 pounds of milk for the 7-day test forms but a hazy idea of what the probable milk yield of the 365-day test will be when this test is applied to the same cow.

From the data and constants given in the earlier sections of this paper it is possible to determine what the most probable 365-day record will be from either of the 7-day tests. Also the most probable record of the 365-day lactation retest may be found from the 365-day test record. These prediction equations are given below. Attention is called to the fact that the numbers of cows available for this comparison were relatively few. This is especially true for the ages three years to four years and four years to five years. The prediction of any milk yield from these equations, under these circumstances, will not be as accurate as if it were possible to base the equations on larger numbers.

365-day expected milk yield at given age	365-day test at given age
Milk yield 1 yr. 9 mo. to 3 yrs.=6706+.442	milk yield 3 yrs. to 4 yrs.
Milk yield 2 yrs. to 3 yrs.=4045+.504	milk yield 4 yrs. to 5 yrs.
Milk yield 2 yrs. to 3 yrs.=6538+.333	milk yield 5 yrs. to 8 yrs.
Milk yield 3 yrs. to 4 yrs.=2499+.750	milk yield 4 yrs. to 5 yrs.
Milk yield 3 yrs. to 4 yrs.=5622+.536	milk yield 5 yrs. to 8 yrs.
Milk yield 4 yrs. to 5 yrs.=6529+.596	milk yield 5 yrs. to 11 yrs.
Milk yield 5 yrs. to 11 yrs.=3975+.738	milk yield 6 yrs. to 13 yrs.

365-day expected milk yield retest at given age	365-day test at given age
Milk yield 3 yrs. to 4 yrs.=—503+1.216	milk yield 1 yr. 9 mo. to 3 yrs.
Milk yield 4 yrs. to 5 yrs.=4882+.987	milk yield 2 yrs. to 3 yrs.
Milk yield 5 yrs. to 8 yrs.=10656+.713	milk yield 2 yrs. to 3 yrs.
Milk yield 4 yrs. to 5 yrs.=4796+.895	milk yield 3 yrs. to 4 yrs.
Milk yield 5 yrs. to 8 yrs.=5349+.919	milk yield 3 yrs. to 4 yrs.
Milk yield 5 yrs. to 11 yrs.=8608+.673	milk yield 4 yrs. to 5 yrs.
Milk yield 6 yrs. to 13 yrs.=8249+.644	milk yield 5 yrs. to 11 yrs.

The case of a two-year-old cow giving 15000 pounds of milk may be taken to illustrate the use of these equations. Suppose the expected milk yield at 4 years to 5 years old is desired. The equation necessary to make this prediction, obtained from the above, is

Milk yield 4 yrs. to 5 yrs.=4882+.987 milk yield 2 yrs. to 3 yrs. multiplying the 2-year-milk yield 15000 by .987 we have 14805+4882=18687 the expected yield at 4 to 5 years. In a similar manner the expected milk yield of other periods may be found from one or the other of the equations given above.

It would be of some interest to have a general prediction equation when the age factor would come in as a part of the equation and not as a choice of different equations. Such an equation is complicated by the logarithmic nature of milk yield and the parabolic or logarithmic nature of the standard deviation curve. It has the advantage that in its calculation the average correlation coefficient could be used, thus striking an average

as to the degree of reliability of a test. The calculation of the necessary constants would entail a good deal of work at this time. Such being the case the presentation of these more complete formulas are reserved for the future.

The prediction equations for the determination of the probable 365-day record from the 7-day record, where the 7-day record is a part of the 365-day record are given below. The equations are also found for the calculation of the probable 7-day record where the 365-day record is known. The numbers on which the equations for the milk yields at the ages older than seven years are based are small. The error in the use of these equations will consequently be large.

PREDICTION EQUATIONS FOR 365-DAY MILK YIELD FROM 7-DAY MILK YIELD, SAME LACTATION

365-day expected yield	7-day actual milk yield
Milk yield 1 yr. 6 mo. to 2 yrs. 0 mo.	=1122+35.1 milk yield 1 yr. 6 mo. to 2 yrs. 0 mo.
Milk yield 2 yrs. 0 mo. to 2 yrs. 6 mo.	=3658+28.0 milk yield 2 yrs. 0 mo. to 2 yrs. 6 mo.
Milk yield 2 yrs. 6 mo. to 3 yrs. 0 mo.	=4556+25.9 milk yield 2 yrs. 6 mo. to 3 yrs. 0 mo.
Milk yield 3 yrs. 0 mo. to 3 yrs. 6 mo.	=10237+11.6 milk yield 3 yrs. 0 mo. to 3 yrs. 6 mo.
Milk yield 3 yrs. 6 mo. to 4 yrs. 0 mo.	=4423+25.4 milk yield 3 yrs. 6 mo. to 4 yrs. 0 mo.
Milk yield 4 yrs. 0 mo. to 4 yrs. 6 mo.	=—720+35.7 milk yield 4 yrs. 0 mo. to 4 yrs. 6 mo.
Milk yield 4 yrs. 6 mo. to 5 yrs. 0 mo.	=9173+17.6 milk yield 4 yrs. 6 mo. to 5 yrs. 0 mo.
Milk yield 5 yrs. 0 mo. to 5 yrs. 6 mo.	=3899+27.9 milk yield 5 yrs. 0 mo. to 5 yrs. 6 mo.
Milk yield 5 yrs. 6 mo. to 6 yrs. 0 mo.	=4713+25.4 milk yield 5 yrs. 6 mo. to 6 yrs. 0 mo.
Milk yield 6 yrs. 0 mo. to 6 yrs. 6 mo.	=4129+28.4 milk yield 6 yrs. 0 mo. to 6 yrs. 6 mo.
Milk yield 6 yrs. 6 mo. to 7 yrs. 0 mo.	=5708+25.2 milk yield 6 yrs. 6 mo. to 7 yrs. 0 mo.
Milk yield 7 yrs. 0 mo. to 7 yrs. 6 mo.	=8187+20.4 milk yield 7 yrs. 0 mo. to 7 yrs. 6 mo.
Milk yield 7 yrs. 6 mo. to 8 yrs. 0 mo.	=—1016+38.9 milk yield 7 yrs. 6 mo. to 8 yrs. 0 mo.
Milk yield 8 yrs. 0 mo. to 8 yrs. 6 mo.	=8843+17.1 milk yield 8 yrs. 0 mo. to 8 yrs. 6 mo.
Milk yield 8 yrs. 6 mo. to 9 yrs. 0 mo.	=7657+19.6 milk yield 8 yrs. 6 mo. to 9 yrs. 0 mo.
Milk yield 9 yrs. 0 mo. to 9 yrs. 6 mo.	=20087—3.5 milk yield 9 yrs. 0 mo. to 9 yrs. 6 mo.
Milk yield 9 yrs. 6 mo. to 11 yrs. 0 mo.	=—1615+35.0 milk yield 9 yrs. 6 mo. to 11 yrs. 0 mo.
Milk yield 11 yrs. 0 mo. to 15 yrs. 0 mo.	=—17618+69.4 milk yield 11 yrs. 0 mo. to 15 yrs. 0 mo.

PREDICTION EQUATIONS FOR 7-DAY MILK YIELD FROM 365-DAY MILK YIELD

7-day expected milk yield	365-day actual milk yield
Milk yield 1 yr. 6 mo. to 2 yrs. 0 mo.	=161+.0121 milk yield 1 yr. 6 mo. to 2 yrs. 0 mo.
Milk yield 2 yrs. 0 mo. to 2 yrs. 6 mo.	=130+.0164 milk yield 2 yrs. 0 mo. to 2 yrs. 6 mo.
Milk yield 2 yrs. 6 mo. to 3 yrs. 0 mo.	=158+.0151 milk yield 2 yrs. 6 mo. to 3 yrs. 0 mo.
Milk yield 3 yrs. 0 mo. to 3 yrs. 6 mo.	=222+.0108 milk yield 3 yrs. 0 mo. to 3 yrs. 6 mo.
Milk yield 3 yrs. 6 mo. to 4 yrs. 0 mo.	=195+.0153 milk yield 3 yrs. 6 mo. to 4 yrs. 0 mo.
Milk yield 4 yrs. 0 mo. to 4 yrs. 6 mo.	=226+.0150 milk yield 4 yrs. 0 mo to 4 yrs. 6 mo.
Milk yield 4 yrs. 6 mo. to 5 yrs. 0 mo.	=270+.0113 milk yield 4 yrs. 6 mo. to 5 yrs. 0 mo.
Milk yield 5 yrs. 0 mo. to 5 yrs. 6 mo.	=278+.0122 milk yield 5 yrs. 0 mo. to 5 yrs. 6 mo.
Milk yield 5 yrs. 6 mo. to 6 yrs. 0 mo.	=279+.0130 milk yield 5 yrs. 6 mo. to 6 yrs. 0 mo.
Milk yield 6 yrs. 0 mo. to 6 yrs. 6 mo.	=237+.0142 milk yield 6 yrs. 0 mo. to 6 yrs. 6 mo.
Milk yield 6 yrs. 6 mo. to 7 yrs. 0 mo	=259+.0136 milk yield 6 yrs. 6 mo. to 7 yrs. 0 mo.
Milk yield 7 yrs. 0 mo. to 7 yrs. 6 mo.	=297+.0111 milk yield 7 yrs. 0 mo. to 7 yrs. 6 mo.
Milk yield 7 yrs. 6 mo. to 8 yrs. 0 mo.	=207+.0162 milk yield 7 yrs. 6 mo. to 8 yrs. 0 mo.
Milk yield 8 yrs. 0 mo. to 8 yrs. 6 mo.	=258+.0157 milk yield 8 yrs. 0 mo. to 8 yrs. 6 mo.
Milk yield 8 yrs. 6 mo. to 9 yrs. 0 mo.	=266+.0138 milk yield 8 yrs. 6 mo. to 9 yrs. 0 mo.
Milk yield 9 yrs. 0 mo. to 9 yrs. 6 mo.	=556—.0038 milk yield 9 yrs. 0 mo. to 9 yrs. 6 mo.
Milk yield 9 yrs. 6 mo. to 11 yrs. 0 mo.	=259+.0156 milk yield 9 yrs. 6 mo. to 11 yrs. 0 mo.
Milk yield 11 yrs. 0 mo. to 15 yrs. 0 mo.	=330+.0101 milk yield 11 yrs. 0 mo. to 15 yrs. 0 mo.

For purposes of illustration, the question may be asked, what will a cow five years old giving 500 pounds of milk in the 7-days be expected to give in 365-days. The equation for predicting the probable yield of the cow is

Milk yield 5 yrs. 0 mo. to 5 yrs. 6 mo.=3899+27.9 milk yield 5 yrs. 0 mo. to 5 yrs. 6 mo.

The milk yield of the cow, 500 pounds, times 27.9 equals 13950+3899=17849 as the probable milk yield of the cow in her 365-day lactation. For any given cow this figure is only approximate since there is a wide variation in the yields of milk of individual cows. Some cows will be more, some less, the figure given is a fair average.

The prediction equations for the 7-day and 365-day tests when the 7-day test is in a different lactation from the 365-day test are given below.

PREDICTION EQUATIONS FOR 365-DAY MILK YIELD FROM 7-DAY MILK YIELD, DIFFERENT LACTATIONS

365-day expected milk yield	7-day actual milk yield
Milk yield 3 yrs. to 4 yrs.=6115+28.6	milk yield 2 yrs. to 3 yrs.
Milk yield 4 yrs. to 5 yrs.=6851+27.8	milk yield 2 yrs. to 3 yrs.
Milk yield 5 yrs. to 6 yrs.=6725+33.2	milk yield 2 yrs. to 3 yrs.
Milk yield 6 yrs. to 10 yrs.=10065+25.3	milk yield 2 yrs. to 3 yrs.
Milk yield 4 yrs. to 5 yrs.=10445+14.1	milk yield 3 yrs. to 4 yrs.
Milk yield 5 yrs. to 6 yrs.=8594+22.6	milk yield 3 yrs. to 4 yrs.
Milk yield 6 yrs. to 10 yrs.=8374+27.0	milk yield 3 yrs. to 4 yrs.
Milk yield 5 yrs. to 6 yrs.=4684+28.8	milk yield 4 yrs. to 5 yrs.
Milk yield 6 yrs. to 10 yrs.=9400+19.2	milk yield 4 yrs. to 5 yrs.
Milk yield 6 yrs. to 10 yrs.=8214+21.5	milk yield 5 yrs. to 6 yrs.

PREDCTION EQUATIONS FOR 7-DAY MILK YIELD FROM 365-DAY MILK YIELD, DIFFERENT LACTATIONS

7-day expected milk yield	365-day actual yield
Milk yield 2 yrs. to 3 yrs.=229+.0071	milk yield 3 yrs. to 4 yrs.
Milk yield 2 yrs. to 3 yrs.=170+.0098	milk yield 4 yrs. to 5 yrs.
Milk yield 2 yrs. to 3 yrs.=142+.0106	milk yield 5 yrs. to 6 yrs.
Milk yield 2 yrs. to 3 yrs.=232+.0041	milk yield 6 yrs. to 10 yrs.
Milk yield 3 yrs. to 4 yrs.=285+.0072	milk yield 4 yrs. to 5 yrs.
Milk yield 3 yrs. to 4 yrs.=278+.0086	milk yield 5 yrs. to 6 yrs.
Milk yield 3 yrs. to 4 yrs.=156+.0114	milk yield 6 yrs. to 10 yrs.
Milk yield 4 yrs. to 5 yrs.=295+.0080	milk yield 5 yrs. to 6 yrs.
Milk yield 4 yrs. to 5 yrs.=72+.0210	milk yield 6 yrs. to 10 yrs.
Milk yield 5 yrs. to 6 yrs.=300+.0091	milk yield 6 yrs. to 10 yrs.

Care should be used in interpreting results derived from the use of the equation for three years to four years and six years to ten years as the numbers on which this equation is based are few.

One illustration of the use of these equations may be desirable. The two year old milk production of a cow for the 7-day test is 300 pounds, what 365-day milk production may be expected of this cow at 5 to 6 years of age. The equation expressing this relationship is

Milk yield 5 yrs. to 6 yrs.=6725+33.2 milk yield 2 yrs. to 3 yrs.
33.2 x 300 =9960.+6725=16685 as the probable milk yield of the cow.

PART II. RELATION BETWEEN THE 7-DAY BUTTER-FAT PERCENTAGE AND THE 365-DAY BUTTER-FAT PERCENTAGE

The data for the 7-day and the 365-day butter-fat percentages is the same as that used for the study of milk yields. The major problems involved and their method of treatment are given in the introduction. The order of treatment will be the same as that used in the exposition of milk yield. The means, standard deviations and coefficients of variation for the 365-day records when correlated with the 365-day retest records are given in Table 9.

TABLE 9.

Physical Constants for the Variation of 365-Day Butter-Fat Percentage in the Milk of Test and Retest Cows

Age Test	Retest	Mean First Test	Standard Deviation First Test	Coefficients of Variation First Test
1 yr. 9 mo. to 3 yrs.	and 3 yrs. to 4 yrs.	3.34±.02	.238±.017	7.12±.50
2 yrs. to 3 yrs.	and 4 yrs. to 5 yrs.	3.43±.03	.332±.023	9.67±.71
2 yrs. to 3 yrs.	and 5 yrs. to 8 yrs.	3.42±.03	.290±.021	8.47±.56
3 yrs. to 4 yrs.	and 4 yrs. to 5 yrs.	3.53±.05	.307±.035	8.70±1.02
3 yrs. to 4 yrs.	and 5 yrs. to 8 yrs.	3.44±.04	.352±.028	10.21±.80
4 yrs. to 5 yrs.	and 5 yrs. to 11 yrs.	3.34±.03	.330±.024	9.88±.73
5 yrs. to 11 yrs.	and 6 yrs. to 13 yrs.	3.42±.02	.284±.017	8.31±.46

Age Test	Retest	Mean Retest	Standard Deviation Retest	Coefficients of Variation Retest
1 yr. 9 mo. to 3 yrs.	and 3 yrs. to 4 yrs.	3.36±.03	.297±.021	8.85±.65
2 yrs. to 3 yrs.	and 4 yrs. to 5 yrs.	3.43±.03	.329±.023	9.61±.71
2 yrs. to 3 yrs.	and 5 yrs. to 8 yrs.	3.45±.03	.317±.023	9.20±.66
3 yrs. to 4 yrs.	and 4 yrs. to 5 yrs.	3.47±.05	.300±.034	8.65±1.02
3 yrs. to 4 yrs.	and 5 yrs. to 8 yrs.	3.48±.04	.319±.025	9.17±.72
4 yrs. to 5 yrs.	and 5 yrs. to 11 yrs.	3.41±.04	.343±.025	10.06±.73
5 yrs. to 11 yrs.	and 6 yrs. to 13 yrs.	3.39±.02	.284±.016	8.38±.46

The age of the Holstein-Friesian advanced registry cow does not materially effect the butter-fat percentage contained in her milk. Since this is the case the data on the butter-fat percentage could be lumped together for age without materially affecting the results. However, since these age divisions were used for the divisions of milk yield, it seems desirable to continue their use throughout this paper.

The mean butter-fat percentages for the first test cows agree closely with those of all 365-day tested Holstein-Friesian cows. The standard deviations of the butter-fat percentage of the 365-day test cows also agree closely with these constants for the 365-day test of all Holstein-Friesian cows. Such being the case the 365-day tested cows which were retested for the year period are a random sample of all Holstein-Friesian cows which are tested for the year period. In view of this fact the results of this study should be of general application to the Holstein-Friesian advanced registry cows as a whole. The retest cows have approximately the same average butter-fat percentage and standard devition of their butter-fat percentage as do the test cows. As noted in other papers the coefficients of variation of butter-fat percentage is only about $\frac{2}{3}$ that of milk yield.

Table 10 presents the data for the relation of 7-day butter-fat percentage to the 365-day butter-fat percentage when both are of the same lactation.

Table 10 shows that the 7-day butter-fat percentage is in excess of the 365-day butter-fat percentage. This fact is one of the bones of contention, for it is argued that if the average butter-fat percentage of the 7-day test is higher than the year butter-fat percentage then reliance cannot be put upon the 7-day butter-fat percentage as an indicator of the probable 365-day butter-fat percentage. Unfortunately such reasoning is by no means necessarily true since it may be that all classes of cows, high or low testing, have their 7-day and 365-day butter-fat raised proportionately. The question is consequently on the relation between the two variables and not primarily a question of means.

The standard deviations of the butter-fat percentage are also higher than those of the 365-day test. This would indicate that either the 7-day test differentiates the cows' true producing capacities more accurately than the 365-day test or that the 7-day test of some cows may be increased in their butter-fat per-

centage through a trick of feeding or management while their equally good sisters are not increased. Here again the answer to the question comes in a study of the relations between the tests.

TABLE 10.

Physical Constants for the Variation of the 7-Day and 365-Day Butter-Fat Percentage when Both Tests are in the Same Lactation

Age	Mean 7-day Butter-Fat Percentage	Standard Deviation 7-day Butter-Fat Percentage	Coefficients of Variation 7-day Butter-Fat Percentage
1 yr. 6 mo. and 2 yrs. 0 mo.	3.59±.04	.386±.025	10.75±.73
2 yrs. 0 mo. and 2 yrs. 6 mo.	3.63±.02	.500±.013	13.80±.36
2 yrs. 6 mo. and 3 yrs. 0 mo.	3.68±.03	.527±.018	14.33±.48
3 yrs. 0 mo. and 3 yrs. 6 mo.	3.70±.03	.507±.022	13.71±.65
3 yrs. 6 mo. and 4 yrs. 0 mo.	3.62±.03	.466±.020	12.89±.57
4 yrs. 0 mo. and 4 yrs. 6 mo.	3.69±.04	.526±.028	14.25±.76
4 yrs. 6 mo. and 5 yrs. 0 mo.	3.68±.04	.491±.027	13.33±.72
5 yrs. 0 mo. and 5 yrs. 6 mo.	3.81±.05	.594±.033	15.61±.92
5 yrs. 6 mo. and 6 yrs. 0 mo.	3.64±.04	.550±.029	15.12±.82
6 yrs. 0 mo. and 6 yrs. 6 mo.	3.72±.04	.428±.029	11.52±.81
6 yrs. 6 mo. and 7 yrs. 0 mo.	3.65±.03	.361±.025	9.90±.69
7 yrs. 0 mo. and 7 yrs. 6 mo.	3.60±.06	.529±.040	14.72±1.16
7 yrs. 6 mo. and 8 yrs. 0 mo.	3.73±.09	.631±.063	16.92±1.74
8 yrs. 0 mo. and 8 yrs. 6 mo.	3.57±.05	.333±.037	9.35±1.02
8 yrs. 6 mo. and 9 yrs. 0 mo.	3.51±.08	.502±.058	14.28±1.65
9 yrs. 0 mo. and 9 yrs. 6 mo.	3.58±.15	.835±.103	23.33±2.98
9 yrs. 6 mo. and 11 yrs. 0 mo.	3.52±.05	.328±.038	9.31±1.05
11 yrs. 0 mo. and 15 yrs. 0 mo.	3.80±.09	.321±.063	8.46±1.57

Age	Mean 365-day Butter-Fat Percentage	Standard Deviation 365-day Butter-Fat Percentage	Coefficients of Variation 365-day Butter-Fat Percentage
1 yr. 6 mo. and 2 yrs. 0 mo.	3.50±.03	.293±.019	8.38±.53
2 yrs. 0 mo. and 2 yrs. 6 mo.	3.42±.01	.297±.008	8.67±.23
2 yrs. 6 mo. and 3 yrs. 0 mo.	3.51±.01	.310±.010	8.86±.31
3 yrs. 0 mo. and 3 yrs. 6 mo.	3.49±.02	.336±.015	9.64±.46
3 yrs. 6 mo. and 4 yrs. 0 mo.	3.42±.02	.312±.013	9.15±.39
4 yrs. 0 mo. and 4 yrs. 6 mo.	3.47±.03	.364±.019	10.49±.54
4 yrs. 6 mo. and 5 yrs. 0 mo.	3.41±.03	.337±.018	9.88±.55
5 yrs. 0 mo. and 5 yrs. 6 mo.	3.48±.03	.346±.019	9.94±.57
5 yrs. 6 mo. and 6 yrs. 0 mo.	3.40±.02	.270±.014	7.95±.43
6 yrs. 0 mo. and 6 yrs. 6 mo.	3.39±.02	.222±.015	6.53±.47
6 yrs. 6 mo. and 7 yrs. 0 mo.	3.42±.02	.245±.017	7.16±.48
7 yrs. 0 mo. and 7 yrs. 6 mo.	3.38±.03	.296±.022	8.76±.68
7 yrs. 6 mo. and 8 yrs. 0 mo.	3.46±.03	.236±.023	6.82±.70
8 yrs. 0 mo. and 8 yrs. 6 mo.	3.37±.03	.176±.020	5.24±.56
8 yrs. 6 mo. and 9 yrs. 0 mo.	3.41±.05	.315±.036	9.26±1.05
9 yrs. 0 mo. and 9 yrs. 6 mo.	3.39±.06	.349±.043	10.29±1.24
9 yrs. 6 mo. and 11 yrs. 0 mo.	3.43±.05	.314±.036	9.15±1.05
11 yrs. 0 mo. and 15 yrs. 0 mo.	3.40±.09	.342±.067	10.05±1.97

The physical constants for the 7-day and 365-day tests where the 7-day test is not a part of the 365-day test are given in Table 11.

TABLE 11.

Physical Constants for the Variation of the 7-Day and 365-Day Butter-Fat Percentage When the 7-Day Record is Made in a Separate Lactation from the 365-Day Record

Age 7-day test and 365-day test	Mean 7-day Butter-Fat Percentage	Standard Deviation 7-day Butter-Fat Percentage	Coefficients of Variation 7-day Butter-Fat Percentage
2 yrs. to 3 yrs. and 3 yrs. to 4 yrs.	3.44±.04	.418±.026	12.15±.74
2 yrs. to 3 yrs. and 4 yrs. to 5 yrs.	3.65±.05	.451±.035	12.37±.94
2 yrs. to 3 yrs. and 5 yrs. to 6 yrs.	3.44±.05	.417±.038	12.13±1.12
2 yrs. to 3 yrs. and 6 yrs. to 10 yrs.	3.49±.04	.369±.029	10.57±.87
3 yrs. to 4 yrs. and 4 yrs. to 5 yrs.	3.59±.05	.436±.033	12.15±.93
3 yrs. to 4 yrs. and 5 yrs. to 6 yrs.	3.51±.06	.461±.044	13.15±1.26
3 yrs. to 4 yrs. and 6 yrs. to 10 yrs.	3.55±.06	.388±.043	10.93±1.22
4 yrs. to 5 yrs. and 5 yrs. to 6 yrs.	3.57±.04	.343±.031	9.61±.91
4 yrs. to 5 yrs. and 6 yrs. to 10 yrs.	3.61±.08	.601±.056	16.65±1.64
5 yrs. to 6 yrs. and 6 yrs. to 10 yrs.	3.58±.05	.446±.039	12.46±1.06

Age 7-day test and 365-day test	Mean 365-day Butter-Fat Percentage	Standard Deviation 365-day Butter-Fat Percentage	Coefficients of Variation 365-day Butter-Fat Percentage
2 yrs. to 3 yrs. and 3 yrs. to 4 yrs.	3.39±.03	.343±.021	10.11±.62
2 yrs. to 3 yrs. and 4 yrs. to 5 yrs.	3.51±.03	.286±.022	8.16±.62
2 yrs. to 3 yrs. and 5 yrs. to 6 yrs.	3.36±.04	.292±.027	8.70±.83
2 yrs. to 3 yrs. and 6 yrs. to 10 yrs.	3.49±.04	.320±.025	9.17±.71
3 yrs. to 4 yrs. and 4 yrs. to 5 yrs.	3.42±.03	.282±.022	8.25±.61
3 yrs. to 4 yrs. and 5 yrs. to 6 yrs.	3.34±.04	.277±.026	8.30±.77
3 yrs. to 4 yrs. and 6 yrs. to 10 yrs.	3.31±.04	.286±.031	8.65±.99
4 yrs. to 5 yrs. and 5 yrs. to 6 yrs.	3.46±.04	.338±.030	9.77±.91
4 yrs. to 5 yrs. and 6 yrs. to 10 yrs.	3.47±.05	.395±.037	11.38±1.04
5 yrs. to 6 yrs. and 6 yrs. to 10 yrs.	3.46±.04	.332±.029	9.60±.88

The data for the 7-day and 365-day tests in different lactations show the 7-day butter-fat percentages to be slightly larger than the 365-day butter-fat percentage. The difference is about one-half as much as the difference between the 7-day and 365-day butter-fat percentage of the same lactations. The difference between the standard deviations of the 7-day and 365-day butter-fat percentages as shown in Table 11 for the different lactations is only about two-thirds the difference of the standard deviation for the 7-day and 365-day test of the same lactations. The differ-

ences in the relative variabilities are also less. From this fact it might be argued that the 7-day test gives a better index of the 365-day butter-fat percentage when it is not of the same lactation as the year test than when it is of the same lactation as the year test, but Table 12 shows such inferences are not justified.

RELATIVE MERITS OF THE 7-DAY AND 365-DAY BUTTER-FAT PERCENTAGE AS INDICATING THE COW'S PRODUCING CAPACITY

The relations between the year tests and retests and the 7-day tests and 365-day tests for butter-fat percentages as carried on in Holstein-Friesian advanced registry work are given in Table 12.

TABLE 12.

Correlation Coefficients for the Variables 365-Day Butter-Fat Percentage and 365-Day Butter-Fat Percentage for Different Lactations, 7-Day Butter-Fat Percentage and 365-Day Butter-Fat Percentage for the Same Lactation, 7-Day Butter-Fat Percentage and 365-Day Butter-Fat Percentage for Different Lactations

365-day Butter-fat Percentage and 365-day Butter-fat Percentage, Different Lactations. Age	Correlation Coefficients
1 yr. 9 mo. to 3 yrs. and 3 yrs. to 4 yrs.	.756±.043
2 yrs. to 3 yrs. and 4 yrs. to 5 yrs.	.789±.038
2 yrs. to 3 yrs. and 5 yrs. to 8 yrs.	.593±.067
3 yrs. to 4 yrs. and 4 yrs. to 5 yrs.	.783±.062
3 yrs. to 4 yrs. and 5 yrs. to 8 yrs.	.702±.057
4 yrs. to 5 yrs. and 5 yrs. to 11 yrs.	.640±.061
5 yrs. to 11 yrs. and 6 yrs. to 13 yrs.	.741±.036
Mean	.715

7-day Butter-fat Percentage and 365-day Butter-fat Percentage, Same Lactation. Age	Correlation Coefficients
1 yr. 6 mo. and 2 yrs. 0 mo.	.601±.059
2 yrs. 0 mo. and 2 yrs. 6 mo.	.559±.025
2 yrs. 6 mo. and 3 yrs. 0 mo.	.549±.033
3 yrs. 0 mo. and 3 yrs. 6 mo.	.539±.045
3 yrs. 6 mo. and 4 yrs. 0 mo.	.509±.045
4 yrs. 0 mo. and 4 yrs. 6 mo.	.540±.053
4 yrs. 6 mo. and 5 yrs. 0 mo.	.548±.054
5 yrs. 0 mo. and 5 yrs. 6 mo.	.636±.047
5 yrs. 6 mo. and 6 yrs. 0 mo.	.579±.050
6 yrs. 0 mo. and 6 yrs. 6 mo.	.381±.081
6 yrs. 6 mo. and 7 yrs. 0 mo.	.406±.080
7 yrs. 0 mo. and 7 yrs. 6 mo.	.628±.065
7 yrs. 6 mo. and 8 yrs. 0 mo.	.499±.106
8 yrs. 0 mo. and 8 yrs. 6 mo.	.643±.093
8 yrs. 6 mo. and 9 yrs. 0 mo.	.498±.123
9 yrs. 0 mo. and 9 yrs. 6 mo.	.505±.130
9 yrs. 6 mo. and 11 yrs. 0 mo.	.907±.029
11 yrs. 0 mo. and 15 yrs. 0 mo.	.030±.275
Mean	.531

7-day Butter-fat Percentage and 365-day Butter-fat Percentage, Different Lactations. Age	Correlation Coefficients
2 yrs. to 3 yrs. and 3 yrs. to 4 yrs.	.412±.072
2 yrs. to 3 yrs. and 4 yrs. to 5 yrs.	.355±.096
2 yrs. to 3 yrs. and 5 yrs. to 6 yrs.	.478±.100
2 yrs. to 3 yrs. and 6 yrs. to 10 yrs.	.329±.099
3 yrs. to 4 yrs. and 4 yrs. to 5 yrs.	.429±.088
3 yrs. to 4 yrs. and 5 yrs. to 6 yrs.	.323±.121
3 yrs. to 4 yrs. and 6 yrs. to 10 yrs.	.279±.143
4 yrs. to 5 yrs. and 5 yrs. to 6 yrs.	.465±.100
4 yrs. to 5 yrs. and 6 yrs. to 10 yrs.	.630±.080
5 yrs. to 6 yrs. and 6 yrs. to 10 yrs.	.534±.088
Mean	.423

The yearly butter-fat percentage is clearly a better measure of a subsequent yearly butter-fat percentage than a 7-day butter-fat percentage is a measure of a subsequent year butter-fat percentage. This holds true whether the 7-day test is a part of the 365-day test or is in a different lactation.

The 7-day test is a better measure of the butter-fat percentage of the 365-day lactation record of which it is a part than it is a measure of the 365-day lactation record of which it is not a part.

All of the correlation coefficients are of good size showing that records as short as 7-days have a good deal of value in predicting what the probable butter-fat percentage of the cow will be under year test conditions.

LINEARITY OF REGRESSION

Before placing too much emphasis on the constants derived above it is desirable to know the character of the regression lines. The correlation ratios and the test for the linearity of regression, correlation ratio squared minus the correlation coefficient squared, are given in Table 13.

TABLE 13.

Data for the Linearity of Regression Test for the Tables Whose Correlation Coefficients are Presented in Table 17

365-day Butter-fat Percentage and 365-day Butter-fat Percentage, Different Lactations Age	Correlation Ratios	η^2-r^2
1 yr. 9 mo. to 3 yrs. and 3 yrs. to 4 yrs.	.787	.049±.043
2 yrs. to 3 yrs. and 4 yrs. to 5 yrs.	.859	.115±.063
2 yrs. to 3 yrs. and 5 yrs. to 8 yrs.	.681	.112±.065
3 yrs. to 4 yrs. and 4 yrs. to 5 yrs.	.843	.097±.094
3 yrs. to 4 yrs. and 5 yrs. to 8 yrs.	.767	.094±.066
4 yrs. to 5 yrs. and 5 yrs. to 11 yrs.	.767	.178±.079
5 yrs. to 11 yrs. and 6 yrs. to 13 yrs.	.772	.047±.034
Average	.782	

7-day Butter-fat Percentage and 365-day Butter-fat Percentage, Same Lactation. Age	Correlation Ratios	η^2-r^2
1 yr. 6 mo. and 2 yrs. 0 mo.	.684	.108±.057
2 yrs. 0 mo. and 2 yrs. 6 mo.	.592	.039±.014
2 yrs. 6 mo. and 3 yrs. 0 mo.	.597	.055±.022
3 yrs. 0 mo. and 3 yrs. 6 mo.	.719	.226±.054
3 yrs. 6 mo. and 4 yrs. 0 mo.	.581	.078±.033
4 yrs. 0 mo. and 4 yrs. 6 mo.	.686	.179±.057
4 yrs. 6 mo. and 5 yrs. 0 mo.	.653	.126±.051
5 yrs. 0 mo. and 5 yrs. 6 mo.	.731	.130±.054
5 yrs. 6 mo. and 6 yrs. 0 mo.	.713	.173±.057
6 yrs. 0 mo. and 6 yrs. 6 mo.	.442	.050±.041
6 yrs. 6 mo. and 7 yrs. 0 mo.	.551	.139±.067
7 yrs. 0 mo. and 7 yrs. 6 mo.	.705	.102±.065
7 yrs. 6 mo. and 8 yrs. 0 mo.	.678	.210±.115
8 yrs. 0 mo. and 8 yrs. 6 mo.	.715	.099±.095
8 yrs. 6 mo. and 9 yrs. 0 mo.	.706	.251±.142
9 yrs. 0 mo. and 9 yrs. 6 mo.	.942	.632±.168
9 yrs. 6 mo. and 11 yrs. 0 mo.	.952	.084±.091
11 yrs. 0 mo. and 15 yrs. 0 mo.	.218	.047±.116
Average	.659	

7-day Butter-fat Percentage and 365-day Butter-fat Percentage, Different Lactations. Age	Correlation Ratios	η^2-r^2
2 yrs. to 3 yrs and 3 yrs. to 4 yrs.	.596	.152±.062
2 yrs. to 3 yrs. and 4 yrs. to 5 yrs.	.561	.043±.044
2 yrs. to 3 yrs. and 5 yrs. to 6 yrs.	.669	.097±.077
2 yrs. to 3 yrs. and 6 yrs. to 10 yrs.	.388	.047±.047
3 yrs. to 4 yrs. and 4 yrs. to 5 yrs.	.455	.106±.067
3 yrs. to 4 yrs. and 5 yrs. to 6 yrs.	.527	.084±.075
3 yrs. to 4 yrs. and 6 yrs. to 10 yrs.	.785	.307±.143
4 yrs. to 5 yrs. and 5 yrs. to 6 yrs.	.738	.315±.118
4 yrs. to 5 yrs. and 6 yrs. to 10 yrs.	.666	.039±.052
5 yrs. to 6 yrs. and 6 yrs. to 10 yrs.	.587	.150±.088
Average	.597	

The correlation ratios, shown in Table 13 are all large. The order of worth of the 365-day and 7-day test as indicators of the year butter-fat percentages is the same as that for Table 12. The difference between the correlation ratios squared and the correlation coefficients squared are practically all under three times the probable error of the differences. Such being the case it is probable that all regression lines are linear.

Relation Shown Between Economic Characters

If an event can be foreseen it can more often be utilized to advantage than if it appears unannounced. If the profitable cow can be selected from the unprofitable cow, or the high laying hen from the poor layer early in life it follows that a profit is made by keeping the first and discarding the second. Such reasons justify the retention of any characters which indicate the subsequent productive value of an animal. The 7-day and 365-day tests have value in predicting future butter-fat percentage. It is of interest to examine some of the other variables used to predict economic characters. Some of these constants are given in Table 6. Those more nearly relating to butter-fat percentage are given in Table 14.

TABLE 14.

Correlation Coefficients Between Characters of Economic Importance

Character	Breed	Correlation	Authority
Butter-fat percentage and butter-fat percentage	Guernsey Advanced Registry	.637 to .893	Gowen[1]
Butter-fat percentage and butter-fat percentage	Jersey pure-bred herd	.247 to .678	Gowen[2]
365-day butter-fat percentage and 365-day butter-fat percentage	Holstein-Friesian Advanced Registry	.593 to .789	This paper
7-day butter-fat percentage and 365-day butter-fat percentage (same lactation)	Holstein-Friesian Advanced Registry	.030 to .907	This paper
7-day butter-fat percentage and 365-day butter-fat percentage (different lactation)	Holstein-Friesian Advanced Registry	.279 to .630	This paper

[1]Gowen, John W. 1921. Studies in Milk Secretion XI. The Relation between the Butter-Fat Percentage of One Lactation and the Butter-Fat Percentage of a subsequent Lactation in Guernsey Advanced Registry Cattle. In press.

[2]———— 1920. Studies in Milk Secretion VI. On the Variations and Correlations of Butter-Fat Percentage with Age in Jersey Cattle. Genetics, Vol. 5, p. 249-324.

The characters in Table 14 deal entirely with the concentration of the butter-fat contained in cow's milk. The average correlation coefficients for each variable is of good size. The value of the year test in predicting the year retest butter-fat percentage is nearly the same for the Guernsey and Holstein-Friesian advanced registry cows. The eight months butter-fat percentage record of the pure bred Jersey herd has a lower prediction value

for the subsequent eight months record than either the Guernsey or Holstein-Friesian year test have for the subsequent retest. It is believed that this lower value is due to the fact that all of the eight months records were for a pure bred Jersey herd under average conditions whereas the Guernsey and Holstein-Friesian cows were a selected group kept under more careful treatment. The 7-day records have a slightly lower predicting value than do the 365-day records.

If the reader turns back to Table 6 and compares the values given in this table with those of Table 14 it will be noted that the year records for milk yield of both the Guernsey and Holstein-Friesian cows have nearly the same predicting value for subsequent milk yield that the butter-fat percentages have for the subsequent butter-fat percentage. The 7-day milk yields have a slightly higher value in predicting the subsequent 365-day records than the 7-day records for butter-fat percentage have for predicting the subsequent 365-day butter-fat percentage. When compared with the other characters used to predict future productions it is clear that both the 7-day and 365-day records have a relatively high value in predicting future production of dairy cattle, well up with those used for egg production and for wool clip.

As noted in Table 6 conformation of the cow is frequently used as a criterion to select cows as milkers. The relation of conformation to milk yield is significant but low compared with the relation of either the 7-day or the 365-day tests to a subsequent 365-day record. The case is worse for butter-fat percentage. Conformation has little or no relation to butter-fat percentage. Under such conditions we are thrown back on a butter-fat test of either long or short duration to determine the probable productive ability of the cow.

Effect of Grouping All Butter-Fat Percentage Records in Determining the Relation of the 7-Day and 365-Day Lactation Records

The lumping together of all records for butter-fat percentage irrespective of age has very little effect on the correlation coefficients for the 7-day and 365-day butter-fat percentage. This comes from the fact that in Holstein-Friesian cows there is very

little correlation between the age of the cow and the butter-fat percentage contained in her milk. The correlation coefficients obtained by grouping all records together are given in Table 15.

TABLE 15.

Correlation Coefficients Between 7-Day and 365-Day Butter-Fat Percentage, the Age of the Cow Disregarded

Characters Correlated	Correlation Coefficients
365-day butter-fat percentage and 365-day butter-fat percentage	.707±.019
7-day butter-fat percentage and 365-day butter-fat percentage (same lactation)	.547±.013
7-day butter-fat percentage and 365-day butter-fat percentage (different lactation)	.477±.024

The results derived from the combination of all data are essentially the same as those where the individual age group are made. The reason for this comes from the fact that age changes do not materially effect the butter-fat percentage of the milk of Holstein-Friesian cows.

CHANGES IN THE VALUE OF THE 7-DAY TEST AS AN INDICATOR OF THE YEAR TEST BUTTER-FAT PERCENTAGE

The claim is made that in recent years the record of the 7-day test may be so modified by feeding, as to be worthless as an indication of the cow's 365-day production. This assertion is directed more particularly at the butter-fat percentage. It is based on the belief that the early records were not influenced by this factor whereas the records of today are materially affected. The critical evidence for testing the truth of this claim comes from a comparison of the correlation coefficients for the 7-day and 365-day records for a group of cows tested early in the history of advanced registry testing with the same coefficients for another group tested just recently. The data used for this point were the 2-year old and the 6- to 9-year old records of cows tested for the 7- and 365-days in the same lactation. Such a division gives a group of young cows and a group of mature cows for comparison. The data on each group were divided into approximately two equal parts. The first group for the 2-year olds

contained herd book numbers from 66417 to 159419, the second group contained numbers from 159486 to 211236. The groups for the 6- to 9-year old cows contained numbers from 49440 to 95253 and 95273 to 158760.

Consideration of the problem shows that if the claim made is correct the groups of cows with the lower herd book numbers should have a higher relation between the 7-day and 365-day records than that found for the correlation between the 7-day and 365-day test with the cows of the higher herd book numbers. If on the other hand there is nothing to the assertion no significant difference should exist between these correlation coefficients. The constants for these relations are given in Table 16.

TABLE 16.

Correlation Coefficients for the 7-Day and 365-Day Butter-Fat Percentage, Grouped to Determine the Relation Between Tests Made Recently and Tests Made Early in the Breed's History in Predicting Probable Future 365-Day Lactation Records for Butter-Fat

Characters Correlated	Correlation Coefficients	Difference
7-day and 365-day butter-fat percentages		
Cows 2-years old		
Herd book Nos. 66417 to 159419	.542±.028	
Herd book Nos. 159486 to 211236	.582±.027	—.040±.039
Cows 6- to 9-years old		
Herd book Nos. 49440 to 95253	.695±.030	
Herd book Nos. 95273 to 158760	.592±.038	.103±.048

The difference in the 2-year old group favor the test of today as the most reliable. The difference for the mature cows favors the 7-day test as applied some years ago. The difference between the correlation coefficients for the early tested and the later tested groups is not significant for either group. Such being the case, the claim that the value of the 7-day test as an indicator of the 365-day test has become less in recent years is not in line with the facts.

Prediction Equations to Determine the Probable 365-Day Lactation Butter-Fat Percentage from the 7-Day or 365-Day Records

As indicated earlier in this paper one of the chief criticisms of the 7-day test comes from the fact that the prediction equations to determine the probable 365-day test from the 7-day test are not known, e. g. the criticism of the 7-day test because it has a higher average butter-fat percentage than the year test. From the data and constants given in the earlier sections of this paper it is possible to form these prediction equations for the 7-day and for the 365-day records.

The prediction equations for the 365-day butter-fat percentage from a previous 365-day lactation's butter-fat percentage are given below. The same caution should be used in the use of these equations as was noted under milk yield.

365-day expected butter-fat percentage at given age	365-day retest at given age
Butter-fat percentage 1 yr. 9 mo. to 3 yrs.=1.31+.636	Butter-fat percentage 3 yrs. to 4 yrs.
Butter-fat percentage 2 yrs. to 3 yrs.=.71+.794	Butter-fat percentage 4 yrs. to 5 yrs.
Butter-fat percentage 2 yrs. to 3 yrs.=1.55+.542	Butter-fat percentage 5 yrs. to 8 yrs.
Butter-fat percentage 3 yrs. to 4 yrs.=.75+.802	Butter-fat percentage 4 yrs. to 5 yrs.
Butter-fat percentage 3 yrs. to 4 yrs.=.75+.774	Butter-fat percentage 5 yrs. to 8 yrs.
Butter-fat percentage 4 yrs. to 5 yrs.=1.24+.616	Butter-fat percentage 5 yrs. to 11 yrs.
Butter-fat percentage 5 yrs. to 11 yrs.=.91+.740	Butter-fat percentage 6 yrs. to 13 yrs.

365-retest expected butter-fat percentage at given age	365-day butter-fat percentage at given age
Butter-fat percentage 3 yrs. to 4 yrs.=.21+.943	Butter-fat percentage 1 yr. 9 mo. to 3 yrs.
Butter-fat percentage 4 yrs. to 5 yrs.=.74+.784	Butter-fat percentage 2 yrs. to 3 yrs.
Butter-fat percentage 5 yrs. to 8 yrs.=1.23+.650	Butter-fat percentage 2 yrs. to 3 yrs.
Butter-fat percentage 4 yrs. to 5 yrs.=.76+.765	Butter-fat percentage 3 yrs. to 4 yrs.
Butter-fat percentage 5 yrs. to 8 yrs.=1.28+.637	Butter-fat percentage 3 yrs. to 4 yrs.
Butter-fat percentage 5 yrs. to 11 yrs.=1.19+.666	Butter-fat percentage 4 yrs. to 5 yrs.
Butter-fat percentage 6 yrs. to 13 yrs.=.86+.742	Butter-fat percentage 5 yrs. to 11 yrs.

As an illustration of the use of these equations we may suppose the case of a cow 2 years old giving in her 365-day test a milk testing 4.0 per cent, what would be her probable butter-fat test at 4 to 5 years of age. The equation to make the desired prediction is

Butter-fat percentage 4 yrs. to 5 yrs.=.74+.784 Butter-fat percentage 2 yrs. to 3 yrs.

Multiplying the 2 year butter-fat percentage, 4.0 by .784 we have 3.14+.74=3.88 as the probable butter-fat test of the second lactation.

The equation for the determination of the probable 365-day record from the 7-day record, when the 7-day record is a part of the 365-day record, are given below. The equations are also formed for the calculation of the probable 7-day record when the 365-day record is known.

365-day expected butter-fat percentage at given age				7-day actual butter-fat percentage				
Butter-fat percentage	1 yr. 6 mo.	to	2 yrs. 0 mo.	=1.86+.457 Butter-fat percentage	1 yr. 6 mo.	to	2 yrs. 0 mo.	
Butter-fat percentage	2 yrs. 0 mo.	to	2 yrs. 6 mo.	=2.22+.331 Butter-fat percentage	2 yrs. 0 mo.	to	2 yrs. 6 mo.	
Butter-fat percentage	2 yrs. 6 mo.	to	3 yrs. 0 mo.	=2.32+.324 Butter-fat percentage	2 yrs. 6 mo.	to	3 yrs. 0 mo.	
Butter-fat percentage	3 yrs. 0 mo.	to	3 yrs. 6 mo.	=2.16+.357 Butter-fat percentage	3 yrs. 0 mo.	to	3 yrs. 6 mo.	
Butter-fat percentage	3 yrs. 6 mo.	to	4 yrs. 0 mo.	=2.18+.341 Butter-fat percentage	3 yrs. 6 mo.	to	4 yrs. 0 mo.	
Butter-fat percentage	4 yrs. 0 mo.	to	4 yrs. 6 mo.	=2.09+.374 Butter-fat percentage	4 yrs. 0 mo.	to	4 yrs. 6 mo.	
Butter-fat percentage	4 yrs. 6 mo.	to	5 yrs. 0 mo.	=2.03+.377 Butter-fat percentage	4 yrs. 6 mo.	to	5 yrs. 0 mo.	
Butter-fat percentage	5 yrs. 0 mo.	to	5 yrs. 6 mo.	=2.07+.370 Butter-fat percentage	5 yrs. 0 mo.	to	5 yrs. 6 mo.	
Butter-fat percentage	5 yrs. 6 mo.	to	6 yrs. 0 mo.	=2.30+.285 Butter-fat percentage	5 yrs. 6 mo.	to	6 yrs. 0 mo.	
Butter-fat percentage	6 yrs. 0 mo.	to	6 yrs. 6 mo.	=2.60+.197 Butter-fat percentage	6 yrs. 0 mo.	to	6 yrs. 6 mo.	
Butter-fat percentage	6 yrs. 6 mo.	to	7 yrs. 0 mo.	=2.42+.276 Butter-fat percentage	6 yrs. 6 mo.	to	7 yrs. 0 mo.	
Butter-fat percentage	7 yrs. 0 mo.	to	7 yrs. 6 mo.	=2.12+.351 Butter-fat percentage	7 yrs. 0 mo.	to	7 yrs. 6 mo.	
Butter-fat percentage	7 yrs. 6 mo.	to	8 yrs. 0 mo.	=2.76+.187 Butter-fat percentage	7 yrs. 6 mo.	to	8 yrs. 0 mo.	
Butter-fat percentage	8 yrs. 0 mo.	to	8 yrs. 6 mo.	=2.15+.340 Butter-fat percentage	8 yrs. 0 mo.	to	8 yrs. 6 mo.	
Butter-fat percentage	8 yrs. 6 mo.	to	9 yrs. 0 mo.	=2.31+.313 Butter-fat percentage	8 yrs. 6 mo.	to	9 yrs. 0 mo.	
Butter-fat percentage	9 yrs. 0 mo.	to	9 yrs. 6 mo.	=2.64+.211 Butter-fat percentage	9 yrs. 0 mo.	to	9 yrs. 6 mo.	
Butter-fat percentage	9 yrs. 6 mo.	to	11 yrs. 0 mo.	=.37+.867 Butter-fat percentage	9 yrs. 6 mo.	to	11 yrs. 0 mo.	
Butter-fat percentage	11 yrs. 0 mo	to	15 yrs. 0 mo.	=3.28+.032 Butter-fat percentage	11 yrs. 0 mo.	to	15 yrs. 0 mo.	

Prediction Equations for 7-Day Butter-Fat Percentage from the 365-Day Butter-Fat Percentage

7-day expected butter-fat percentage at given age							365-day actual butter-fat percentage						
Butter-fat percentage	1 yr.	6 mo. to	2 yrs.	0 mo. =	.82 +	.789	Butter-fat percentage	1 yr.	6 mo. to	2 yrs.	0 mo.
Butter-fat percentage	2 yrs.	0 mo. to	2 yrs.	6 mo. =	.40 +	.942	Butter-fat percentage	2 yrs.	0 mo. to	2 yrs.	6 mo.
Butter-fat percentage	2 yrs.	6 mo. to	3 yrs.	0 mo. =	.41 +	.932	Butter-fat percentage	2 yrs.	6 mo. to	3 yrs.	0 mo.
Butter-fat percentage	3 yrs.	0 mo. to	3 yrs.	6 mo. =	.86 +	.814	Butter-fat percentage	3 yrs.	0 mo. to	3 yrs.	6 mo.
Butter-fat percentage	3 yrs.	6 mo. to	4 yrs.	0 mo. =	1.02 +	.760	Butter-fat percentage	3 yrs.	6 mo. to	4 yrs.	0 mo.
Butter-fat percentage	4 yrs.	0 mo. to	4 yrs.	6 mo. =	.98 +	.781	Butter-fat percentage	4 yrs.	0 mo. to	4 yrs.	6 mo.
Butter-fat percentage	4 yrs.	6 mo. to	5 yrs.	0 mo. =	.56 +	.798	Butter-fat percentage	4 yrs.	6 mo. to	5 yrs.	0 mo.
Butter-fat percentage	5 yrs.	0 mo. to	5 yrs.	6 mo. =	.00 +	1.093	Butter-fat percentage	5 yrs.	0 mo. to	5 yrs.	6 mo.
Butter-fat percentage	5 yrs.	6 mo. to	6 yrs.	0 mo. =	— .37 +	1.179	Butter-fat percentage	5 yrs.	6 mo. to	6 yrs.	0 mo.
Butter-fat percentage	6 yrs.	0 mo. to	6 yrs.	6 mo. =	1.22 +	.735	Butter-fat percentage	6 yrs.	0 mo. to	6 yrs.	6 mo.
Butter-fat percentage	6 yrs.	6 mo. to	7 yrs.	0 mo. =	1.60 +	.597	Butter-fat percentage	6 yrs.	6 mo. to	7 yrs.	0 mo.
Butter-fat percentage	7 yrs.	0 mo. to	7 yrs.	6 mo. =	— .20 +	1.123	Butter-fat percentage	7 yrs.	0 mo. to	7 yrs.	6 mo.
Butter-fat percentage	7 yrs.	6 mo. to	8 yrs.	0 mo. =	— .80 +	1.337	Butter-fat percentage	7 yrs.	6 mo. to	8 yrs.	0 mo.
Butter-fat percentage	8 yrs.	0 mo. to	8 yrs.	6 mo. =	— .52 +	1.214	Butter-fat percentage	8 yrs.	0 mo. to	8 yrs.	6 mo.
Butter-fat percentage	8 yrs.	6 mo. to	9 yrs.	0 mo. =	.81 +	.792	Butter-fat percentage	8 yrs.	6 mo. to	9 yrs.	0 mo.
Butter-fat percentage	9 yrs.	0 mo. to	9 yrs.	6 mo. =	— .52 +	1.207	Butter-fat percentage	9 yrs.	0 mo. to	9 yrs.	6 mo.
Butter-fat percentage	9 yrs.	6 mo. to	11 yrs.	0 mo. =	.27 +	.948	Butter-fat percentage	9 yrs.	6 mo. to	11 yrs.	0 mo.
Butter-fat percentage	11 yrs.	0 mo. to	15 yrs.	0 mo. =	3.70 +	.029	Butter-fat percentage	11 yrs.	0 mo. to	15 yrs.	0 mo.

As an illustration of the use of these equations, the question may be asked what butter-fat percentage would a cow be likely to give in her milk in the 365-day test if her 7-day test was 4.0 per

cent, the age of the cow being 4 years 3 months. The equation for the prediction of the year test record is

Butter-fat percentage 4 yrs. 0 mo. to 4 yrs. 6 mo.=2.09+.374 Butter-fat percentage 4 yrs. 0 mo. to 4 yrs. 6 mo.

.374 x 4.0=1.50+2.09=3.59 the expected butter-fat percentage of the year test.

The prediction equations for the 7-day and 365-day butter-fat percentage test when the 7-day test is in a different lactation from the 365-day test are given below.

365-day expected butter-fat percentage	7-day actual butter-fat percentage
Butter-fat percentage 3 yrs. to 4 yrs.=2.23+.337	Butter-fat percentage 2 yrs. to 3 yrs.
Butter-fat percentage 4 yrs. to 5 yrs.=2.69+.225	Butter-fat percentage 2 yrs. to 3 yrs.
Butter-fat percentage 5 yrs. to 6 yrs.=2.21+.335	Butter-fat percentage 2 yrs. to 3 yrs.
Butter-fat percentage 6 yrs. to 10 yrs.=2.50+.286	Butter-fat percentage 2 yrs. to 3 yrs.
Butter-fat percentage 4 yrs. to 5 yrs.=2.42+.276	Butter-fat percentage 3 yrs. to 4 yrs.
Butter-fat percentage 5 yrs. to 6 yrs.=2.66+.194	Butter-fat percentage 3 yrs. to 4 yrs.
Butter-fat percentage 6 yrs. to 10 yrs.=2.58+.206	Butter-fat percentage 3 yrs. to 4 yrs.
Butter-fat percentage 5 yrs. to 6 yrs.=1.83+.457	Butter-fat percentage 4 yrs. to 5 yrs.
Butter-fat percentage 6 yrs. to 10 yrs.=1.97+.414	Butter-fat percentage 4 yrs. to 5 yrs.
Butter-fat percentage 6 yrs. to 10 yrs.=2.03+.398	Butter-fat percentage 5 yrs. to 6 yrs.

PREDICTION EQUATIONS TO DETERMINE THE 7-DAY BUTTER-FAT PERCENTAGE FROM 365-DAY BUTTER-FAT PERCENTAGE, DIFFERENT LACTATIONS

7-day expected butter-fat percentage	365-day actual butter-fat percentage
Butter-fat percentage 2 yrs. to 3 yrs.=1.74+.502	Butter-fat percentage 3 yrs. to 4 yrs.
Butter-fat percentage 2 yrs. to 3 yrs.=1.69+.559	Butter-fat percentage 4 yrs. to 5 yrs.
Butter-fat percentage 2 yrs. to 3 yrs.=1.15+.683	Butter-fat percentage 5 yrs. to 6 yrs.
Butter-fat percentage 2 yrs. to 3 yrs.=2.17+.378	Butter-fat percentage 6 yrs. to 10 yrs.
Butter-fat percentage 3 yrs. to 4 yrs.=1.32+.664	Butter-fat percentage 4 yrs. to 5 yrs.
Butter-fat percentage 3 yrs. to 4 yrs.=1.71+.537	Butter-fat percentage 5 yrs. to 6 yrs.
Butter-fat percentage 3 yrs. to 4 yrs.=2.30+.378	Butter-fat percentage 6 yrs. to 10 yrs.
Butter-fat percentage 4 yrs. to 5 yrs.=1.94+.472	Butter-fat percentage 5 yrs. to 6 yrs.
Butter-fat percentage 4 yrs. to 5 yrs.=.28+.958	Butter-fat percentage 6 yrs. to 10 yrs.
Butter-fat percentage 5 yrs. to 6yrs.=1.10+.717	Butter-fat percentage 6 yrs. to 10 yrs.

The use of these equations is entirely similar to any of the others illustrated above. If a cow gives a 4 per cent milk in the 7-day test at 2-years old, what will be her probable butter-fat test in her 5 year old 365-day lactation. The equation for this is

Butter-fat percentage 5 yrs. to 6 yrs.=2.21+.335 butter-fat percentage 2 yrs. to 3 yrs.

.335 x 4.0=1.34+2.21=3.55 the probable butter-fat test in the 5 year old 365-day lactation.

The butter-fat yield of a cow is dependent on the amount of milk the cow yields and on the butter-fat percentage contained in

the milk. The primary variables are consequently milk yield and butter-fat percentage. As these variables have been treated in the previous sections it does not seem essential to the good of the dairy industry to give the analysis of the secondary variable, amount of butter-fat. This is especially true in view of the fact that the results of the analysis of the butter-fat are in agreement with those given for the primary variables milk yield and butter-fat percentage. The prediction of the probable butter-fat yield may be obtained from equations formed directly or it may be determined from the equations for milk yield and for butter-fat percentage as previously given. While the second method is somewhat longer it seems to be the better because it focuses the attention on the prime variables, milk yield and butter-fat percentage.

Bearing of these Results on the General Problem of Testing Dairy Cattle

Another quantitative study has been made of certain phases of the problem of advanced registry testing by Mr. Yapp. Among other points not discussed in this paper but analyzed by Mr. Yapp are the accuracy of the semi-official test, the relation between the butter-fat test of the 7-day period to the 7-day butter-fat, the relation between the 365-day butter-fat percentage and the 365-day butter-fat, the comparison between the 7-day and 30-day butter-fat percentage and the 7-day test and 7-day test eight months after calving.

He shows on a herd of 30 cows kept at the University of Illinois that the butter-fat test by the semi-official method agrees closely with the butter-fat test of these cows kept on continuous test. From this the deduction is drawn that the semi-official test is a fairly accurate measure of the producing ability of the cow. Such an analysis does not quite answer the problem, however. What we really wish to know is how much the 365-day semi-official test may be influenced by the same or like methods which are claimed to influence the 7-day test. That the semi-official record may be influenced by feeding and management can, we think, be proved. The proof of this statement is circumstantial rather than direct. If the names of the cows who are high in butter-fat percentage be tabulated (and this applies to most

breeds) it will be found that the same man's name appears time and again as owner of these cows at the time they were tested. Furthermore this man may have bred few or none of these cows. Not only that but they come from different families often of diverse breeding. Under these circumstances heredity could have little to do with the cow's butter-fat percentage, in fact the conclusion is almost irresistible that feeding and care have influenced the test.

The authors know of no adequate data to approach the solution of the amount by which the semi-official record may be influenced by feeding and management. The official records offer no criterion as there would be no inducement for a feeder to raise the monthly test above the average of the official test. It might be possible to get some notion of the amount of this effect by a comparison of a semi-official record and another official record of different lactations for the same cow. Such records are scarce and are quite unsatisfactory as many semi-official tested cows may not be subjected to the trick of feeding or management which will cause the test to increase beyond the point which would indicate the cow's true production for all her milk in the year.

Mr. Yapp shows the 7-day butter-fat percentage to have a greater relation to the 7-day butter-fat (correlation ratio=.43[9]) than the 365-day butter-fat percentage has with the 365-day butter-fat (correlation ratio=.26[9]).

In a comparison of the 7-day test and the 30-day test Mr. Yapp finds that the 7-day butter-fat percentage parallels the 30-day butter-fat percentage but is between .1 to .25 per cent of butter-fat above the 30-day percentage.

The present paper shows that the coefficients of variation for the 7-day test's milk production are less than are the coefficients of variation for the 365-day test's milk production. This is true whether the 7-day test is a part of the 365-day test or is in a separate lactation. The coefficients of variation for the 7-day test's butter-fat percentage are larger than the coefficients of variation for the 365-day test's butter-fat percentage, and this holds true whether the 7-day test is a part of the 365-day test or is in a separate lactation from it. Such results do not assist materially in the evaluation of the 7-day test or the 365-day test

[9]Calculated by the authors of this paper from Mr. Yapp's data.

as the better-measure of the cow's productive capacity. The mean butter-fat percentage of the 7-day test is higher than the 365-day test. This offers no criterion between the two tests for why should we expect the two tests to be the same. We do not expect the 7-day milk yield to equal the 365-day milk yield. It merely shows us that necessary adjuncts to each of these tests are the conversion factors to determine the probable record of one test from the known record of the other.

The whole question hinges largely upon the relative amounts of correlation between the 7-day and the 365-day tests. The correlation coefficients for the 365-day test with the 365-day test are high for both the milk yield and butter-fat percentage. The correlation coefficients between the 7-day and 365-day tests of which the 7-day test is a part of the 365-day are also high but not so large as those for the year test and retest. The correlation coefficients for the 7-day and 365-day tests where the 7-day test is not a part of the 365-day test are also large. They are less than either of the two preceding correlation coefficients, however. These results are based on age divided records so that the effect of age on milk yield should be largely eliminated.

As all regressions are linear the correlation coefficients should closely represent the true relation between the variables.

The grouping of all records together changes the order of merit of the 7-day and 365-day tests. This is due largely to age, the data becoming heterogeneous because of the shift in the mean milk yield of any group of cows with advancing age.

When the data for the two-year olds and the six-to nine-year olds are divided to give two nearly equal groups, the first tested early in the breed's history and the second tested recently, and a comparison made for these groups it is seen that the 7-day test is as good an indicator of the 365-day's production today as it was when the tests were first used.

The real merits of the 7-day and the 365-day records as measures of the cow's producing ability can be properly determined only by comparison with similar variables used to predict other events. The relative merits of the 365-day records for milk yield or butter-fat percentage as indicators of the probable 365-day records for milk yield or butter-fat percentage are practically the same. The value of these records in predicting subsequent records is also closely similar to those for the same vari-

ables in Guernsey advanced registry cattle. The advanced registry records have a greater predicting value for subsequent long time records than similar records for a pure bred Jersey herd have for predicting subsequent production. The 365-day records are more accurate in predicting the probable milk yield of a subsequent 365-day record than any point in the cow's conformation, not only that but the butter-fat test on this milk indicates quite clearly the cow's probable butter-fat test at some future lactation whereas conformation does not. The 365-day record is a better indicator of a subsequent lactation record than the egg production of one month is of the egg production of a year, or the wool clip of one season is of the wool clip of another season.

The 7-day record predicts the probable 365-day record of which it is a part more accurately than it does the 365-day record of which it is not a part. It has a prediction value slightly less than that of the 365-day test. The 7-day test for milk yield and butter-fat percentage have a value in predicting 365-day milk yield and butter-fat percentage closely similar to that of the wool clip of one season with the wool clip of another season or an egg production of a month for the egg production of a year. The value of the 7-day test is much greater than the value of any point in conformation in predicting milk yield or butter-fat percentage. From this comparison the 7-day record is clearly valuable in predicting the cow's subsequent production. It is not quite so valuable as the 365-day test applied to this same purpose. Both records seem to have merits unto themselves and a predicting value high enough to be worthy of retention.

The value of these different forms of records comes chiefly in knowing the conversion factors necessary to give the probable subsequent production. These conversion factors show that there is no particular detriment in the fact that the 7-day butter-fat percentage is slightly in access of the 365-day butter-fat percentage.

It was hoped to publish the correlation tables showing the data, in an easily checked form, on which these conclusions are based. The cost of printing has made this impossible. The tables will be available, however, at this station. Furthermore the tables can be easily reformed from the data given in the Advanced Registries.